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LIVE ARTICLES
ON
SPECIAL HAZARDS

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FOREWORD

The twelfth annual volume of Live Articles on Special Hazards presents several new and unique features for the consideration of fire underwriters, notably a study of the fire dangers of various acids and their processes of manufacture. Use and occupancy insurance is a constant field for valuable study and is presented in this volume by an acknowledged authority. Several of the subjects appearing in previous volumes are treated again in their up-to-date phases, as the developments of processes and the changes of hazards involve constant attention from year to year if the student of the business is to keep abreast of the times. This series of educational books has proved the best available text-book for many courses in fire insurance and is well supplemented for the student of all lines of indemnity by the complemental series Live Articles on Marine Insurance and Live Articles on Suretyship, which are published annually in the same convenient pocket size at the same price. The increasing interest in these volumes arises from the careful study of the subjects treated by our contributors, who are all experts in their particular lines and to whom the publishers wish to accord the highest credit and their thanks as well.

An index of subjects to be found in all twelve volumes of Live Articles on Special Hazards, will be found in the back of this book.

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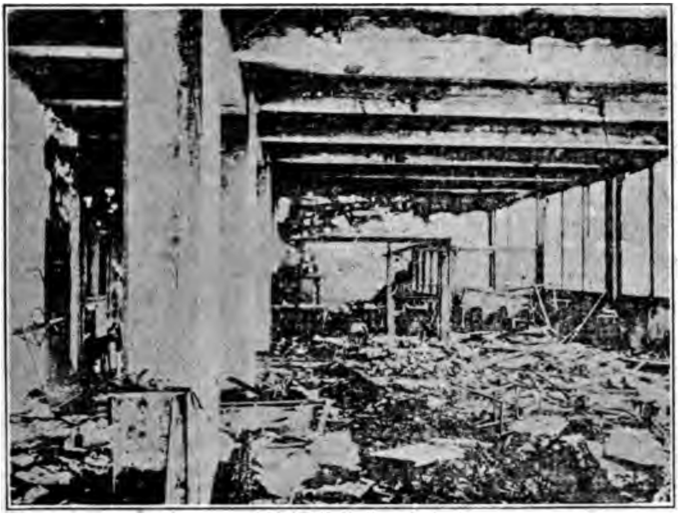
COTTON WAREHOUSES

Their Construction and Protection—Standards to Be Observed —Precautions Against Fire Primary Factors in Design

J. M. Workman in Bulletin of U. S. Dept. of Agriculture

The majority of cotton warehouses do not combine the essentials for real economy of construction and fire protection with advantageous insurance rates largely because of inefficient planning. The design and construction of the cotton warehouse should be handled by a competent engineer having a thorough understanding of construction, fire protection, insurance requirements and rates, together with some knowledge of warehouse management.



Damage to Building Slight

Certain conditions vitally affect the adoption of both site and arrangement of the plant, such as whether cotton is handled primarily for producers or dealers, with the consequent influence on "turn overs" and "peak loads," whether it is deposited and withdrawn in large or small lots, is generally for shipment to local or to distant points, is stored flat or compressed, is subject to favorable shipping rates.

The site for the plant should be considered with reference to transportation facilities, area available, topography of the ground, character of the soil and the water supply. Transportation connections by both water and rail are desirable, while for the plant handling cotton in large quantities for distant delivery, as at concentration points, such connections may be indispensable. The area available may limit the distribution of the buildings and consequently the design. The topography of the ground influences both arrangements and design, while the character of the soil sometimes affects the cost of construction with a resulting influence on economy of design. As a rule, no warehouse should be built unless it can be provided with a sufficient water supply for reasonable fire service.

The layout of the plant, or the arrangement of the buildings, should be influenced primarily by the elements of fire hazard, convenience for handling cotton, and the design of the building desired considered with the economical type of construction. Protection against fire exposure demands isolation of buildings and restriction in size of units. At the same time, the arrangement should be such as affords the greatest economy in handling the cotton, which preferably should be moved into the warehouse from one side and turned out from the opposite side. The design of buildings with reference to size and proportion of compartments, story height, and number of stories should be based upon all of the foregoing facts considered in conjunction with the relative cost of various types of construction and the resulting rate of insurance.

Plants in which the buildings present exposures to each other, or plants subjected to dangerous exterior exposures (including a passing locomotive) should not depend entirely on fire-protective equipment, but should offer in themselves a strong resistance to fire. Congested handling of cotton in courts between warehouses causes such buildings to present a hazard to each other that may be very serious. An inexpensive method of securing protection from such exposures is to use masonry for the exposed walls and frame construction for the walls not exposed. In the case of a number of parallel buildings with courts between only one exterior side wall of each entire building may be masonry. Such an arrangement is good, but is not nearly so satisfactory as when all walls are masonry.

Slow-burning construction buildings should not exceed three stories in height unless there are floors of reinforced concrete to serve as fire breaks. If any floors in the building are fire resistive, or if the exterior exposure is hazardous, doors should be covered with tin as described for fire doors under "fire-resistive construction," or should be otherwise equivalent to fire doors. Iron ladders give ready access to the doors.

Fire-resistive construction for the warehouse does not involve any radical departure in design from the slow-burning construction described. The difference is that all floors and roof are of fire-resistive material, such as reinforced concrete, and that openings are fully protected as required by their location and exposure.

Division Wall Held This Fire

HANDLING EQUIPMENT

Handling equipment should be provided for at the time of construction. The two-wheel truck is in general use. These may be had constructed entirely of steel.

Large plants are using the electric storage battery truck or tractor and trailers to a considerable extent. The latter arrangement is quite satisfactory for cotton handling. The low trailer cars are easily loaded without lifting the cotton. They are arranged to follow the tractor accurately, so that a train of several cars is carried readily through doors and around corners. These tractors may be operated inside the storage compartment without danger of fire. Batteries are charged at night and operated all day.

Several large warehouses use an overhead trolley system. While this system is developed well for these particular plants, it is not recommended for the average warehouse.

In the warehouse of several stories elevating equipment usually is needed in addition to trucks. Two-story warehouses occasionally can be arranged so that cotton is received on the level of the upper floor, 4 feet above the driveway or railway siding. The bales may then be trucked down an inclined platform or sent down a sliding chute. In such case it is necessary to provide a railway siding depressed sufficiently to bring the car floor to the platform level. Unfortunately, such arrangements seldom can be made economically. There are but few conditions which justify the labor of trucking up an incline, so that elevating equipment usually must be provided.

A development of the incline for elevating cotton placed on the two-wheel truck consists of an incline, preferably of reinforced concrete, containing a slot in which travels an endless sprocket chain having bracket or hook links at intervals. These hooks engage the axle of the truck and pull it up the incline, the truckman holding the handles as shown. The endless chain is driven by an electric motor or other power. The truck is generally brought down an incline which is similar except that the sprocket chain is omitted and the slope is less steep.

The electric hoist is valuable in a warehouse in which cotton is handled rapidly. The machinery is protected. Two motors supply both vertical and lateral movement to the steel hooks carrying the bale. This equipment can be housed under the warehouse roof and controlled from any floor by a cable at the doors.

The ordinary spiral package chute of sufficient size supplies the best means for lowering cotton. The chute may pass through a number of floors and, by the use of trap doors, bales may be delivered from any floor to any other floor below.

Where the conditions do not demand rapid elevation of the cotton or where available labor is limited the regular platform elevator is the best hoisting equipment.

In addition to these forms of handling equipment the slatted belt conveyor arranged on an incline and with spiked slats for engaging the bales of cotton is used to some extent.

For piling cotton the machine in most general use is a small portable elevator. The hand machines are necessarily rather slow in operation when elevating a bale of cotton, but the electric machines make possible very rapid piling. When they are equipped with a properly enclosed motor, the machine affords practically no fire hazard, provided the wiring and all connections are properly designed and installed. In cases where the cable is allowed to lie on the floor and is not inclosed there is introduced a serious fire hazard because of the probable damage to the cable from trucks passing over it.

PLANT AND BUILDINGS

Local conditions influence the layout of the warehouse to such an extent that the arrangement of buildings should be decided upon after consideration of these factors and with the approval of the insurance rating bureau having supervision of the particular territory involved.

Fundamental requirements for the arrangements of buildings not only demand that they be isolated as much as possible from adjacent property hazards, but that the several buildings should be arranged in such manner as to minimize the exposure, or fire hazard, that they present to each other. This is so important that it should be the first consideration

THIS WAREHOUSE WITHSTOOD FIRE

in the design of the plant. Among exterior fire hazards a passing locomotive should not be overlooked.

The buildings necessary for a complete warehouse plant vary according to the nature of the business conducted. In addition to the warehouse storage compartments there may be the compress compartment, sheds for receiving and delivering cotton, boiler house, pump house, hose or hydrant houses, office and classing rooms (which may provide a file room for cotton samples), and a watchman's room. Each of these buildings presents definite requirements for construction and fire protection.

The design of the warehouse buildings should be selected with a view to the cost of construction, maintenance and operation on the one hand, and resulting fire hazard and insurance rates on the other. The most important item from both standpoints is the size and proportions of the compartments. After the capacity of the compartment is determined, its proportions must be considered in adopting a particular type of construction. The design of the building as regards the number of stories is usually determined by local conditions, but, all things considered, the single story warehouse is to be preferred in the majority of cases, if cotton can be piled with reasonable convenience. If cotton is not piled, the building of several stories is more economical and convenient.

The warehouse building should be divided into compartments in order to reduce as far as is economically practical the amount of cotton which may be subjected to a single fire. A compartment may be considered as that portion of the building which is cut off from all other parts of the building by fire-resistive division walls, or such walls and fire-resistive floors so combined that a fire will not be communicated readily from one of these sections to another. This reduction of single areas and protection of each against the other is a principle of the greatest importance in cotton warehousing.

THE COMPARTMENT

The size of the compartment should be such as to limit the cotton which may be stored therein to an amount of reasonable value. It usually is conceded as desirable that the size of the compartment should not permit the storage of more than 600 bales of cotton, while in few cases should the number of bales exceed 1,000. This view of the capacity of the storage compartment conforms to the usual insurance standard of volume having a preferred limitation of 72,000 cubic feet, with progressive penalties in rates of insurance when this volume is exceeded. The limitation of volume is probably the fairest method of limiting capacity in bales.

The area and proportions of the compartment should depend upon still other factors, such as economy of cotton handling, cost of construction, adaptation to withstand fire and to permit effective use of water from sprinklers, hose streams and hand appliances, and adequate daylight diffusion.

FIRE-RESISTIVE CONSTRUCTION

Fire-resistive—sometimes called "fireproof"—construction for the warehouse ranks first both in protection against fire and in low cost of maintenance and depreciation charges. However, the first cost is more than that for the other types of construction. For this reason it is not to be preferred usually to the best design of slow-burning construction, for single story warehouses. On the other hand, fire-resistive construction should be used for warehouses several stories high whenever possible, and for the single story plant which is badly congested or severely exposed.

Essential features of fire-resistive construction are the superior fire-resistive nature of material used in construction of all walls, floors, roof, structural members and details, together with such arrangement and assembly of this material as will protect the contents of the building against fires of external origin and the spread of fires originating inside, and will result in minimum damage to the building itself. It should be noted that any type of building in which combustible material is stored may be subjected to the most severe test from internal fires. Therefore the construction of the building should be such as to withstand an intense and sustained fire and, at the same time, afford the best opportunity for use of fire-protective equipment. The important features of this construction may be considered as the division fire walls, exterior walls, roof, floors and openings.

AUTOMATIC DOOR CLOSERS

Closing devices much more sensitive than the fusible link now available for use on fire doors. The fusible link requires heating of the solder and surrounding metal to a temperature above 165° F. The length of time required depends on the intensity of the heat at the door which may be placed some distance from the origin of the fire, or subject to conditions which would allow the fire to spread through the opening before closing action of the door. The improved closing devices either provide heat detectors at intervals over the ceiling or provide near the door a single heat detector which responds to a sudden rise of temperature.

As an example of these principles, there is a device which is provided with a heat detector which closes the door to which it is connected when the temperature rises more rapidly than is occasioned by weather or working changes. It is not necessary that the heat reach any fixed temperature, but simply that there be a sudden rise of temperature at the location of the heat detector which may be at the door or a distance from it, or there may be several detectors provided at different places. These detectors may be installed on both sides of the division wall and operate a door on either or both sides, the releasing mechanism usually being on the wall and near the door. The heat detector is connected with the door-releasing mechanism by an air tube and the motive power is supplied by the rate of rise in temperature at the location of any of the detectors. Such a device is extremely sensitive to heat even though the source of the heat be in a distant part of the compartment. No connections of any kind independent of it are required and no electricity is used.

Another instance of a sensitive door closer is a device based, not as the first on relative change of temperature, but on response to a fixed temperature exceeding 165 degrees F. with means of detecting such temperature placed in different parts of the compartment. This is accomplished by a device which makes an electrical connection when the given temperature is reached. With this system, electrical current may be taken from any constant supply or from a storage battery or both. Unless the installation provides an alarm system which will indicate interruption in supply of current the battery should be used. This device also supplies an atuomatic fire alarm. It may be connected to the sprinkler system so that when this is called into play all fire doors will be closed.

The new and improved door-closing devices are establishing a good record, but it must be remembered that the simple fusible link has given positive service and a reasonable degree of protection for many years. It is unwise to discard this simple link, but it is desirable that it be supplemented by one of the more sensitive devices.

SLOW-BURNING CONSTRUCTION

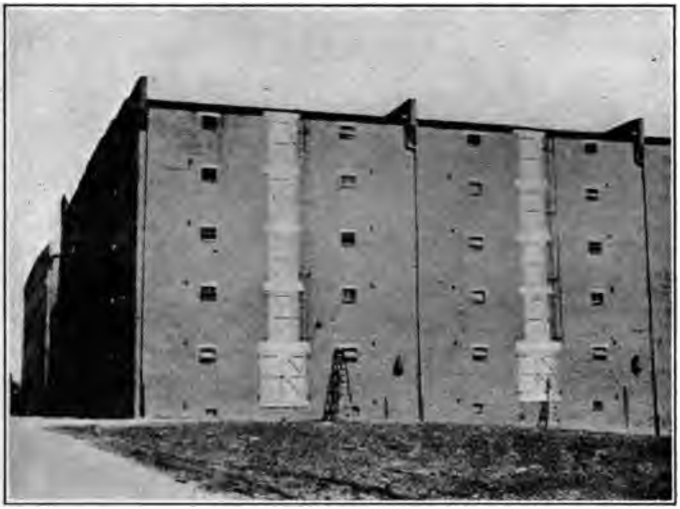
Slow-burning construction is well suited to the requirements of the cotton warehouse, although this construction does not afford such a high degree of protection as fire-resistive construction. The storage house for cotton, however, presents a combination of values of distinct contrast to many buildings in that the value of the cotton stored so very far exceeds the value of the building which protects it. Although the building of reinforced concrete will remain practically undamaged after its contents have been entirely consumed, the *building of* good slow-burning design will retard materially the action of fire and provide very favorable conditions for extinguishment. With acceptable designs for warehouse compartments of this construction, fire frequently can be confined to the section in which it originated. Hence, the compartment is still the unit of the warehouse, as it is in case of the fire-resistive construction. The same general influences control its preferred size and proportions except that its limitations must be fixed entirely by walls, the floors not serving to separate compartment units, in case of multiple story construction.

ROOFING

Roofing should conform to the same requisite set forth for material used in fire-resistive construction, although there is slightly more latitude here inasmuch as the material should be applied with nails. The variety of material and construction is usually limited to those adapted to roofs of very slight pitch since this slight incline is pre-eminent for warehouse designs. That the roofing material should be non-inflammable is of even greater importance for this construction than for the fire-resistive. In the case of a concrete slab the danger would be limited to access of sparks through ventilators and skylights and all fire damage would be confined to the possible loss of the roofing material. On the contrary, for slow-burning construction, the roofing material itself must serve as a protection to the roof planking against exterior fire. Furthermore, the roofing is called upon to resist the lifting, or "sucking," action of wind and, therefore, must have either considerable strength or weight or both.

There are certain elements peculiar to a fire in a cotton warehouse which render unsuitable for roofing some materials, such as tin and sheet iron, which are well suited to other purposes. It is true that these materials are proof against spark hazard from external sources, but they present a serious handicap to the extinguishment of fire which has originated in or gained access to an individual compartment. Some critics hold that the chief objection to tin or sheet iron is that when the supporting framing is burned away the metal falls upon the cotton and prevents effective application of water with a consequent heavy loss of the cotton. Others hold that it is better in case of fire that a hole be burned through the roof so as to permit the direct escape of heat and smoke in order that all openings may be used more readily for application of water. Such action is retarded when the burning framing with metal clinging to it falls bodily on the cotton. The comparison roofings, on the other hand, break up under such conditions and do not present any material hazard. Certainly, the feature of salvage from a cotton fire is sufficient to make the use of metal roofings inadvisable unless applied over 2-inch planking, which would not collapse quickly. Even then, it should be adopted only with great reluctance. The roofing most fully suited to the requirements of the nearly flat roof of the cotton warehouse is tar and gravel of good material carefully applied. Its cost of upkeep is very low, while with a tin roof the cost of painting required is considerable.

The junction of roofing with parapet walls should be made watertight by extending the flashing an ample distance up the side of the wall and counter-flashing with suitable material built into the brick joint or suitable recess.



Doors and Ladders for Fire Use

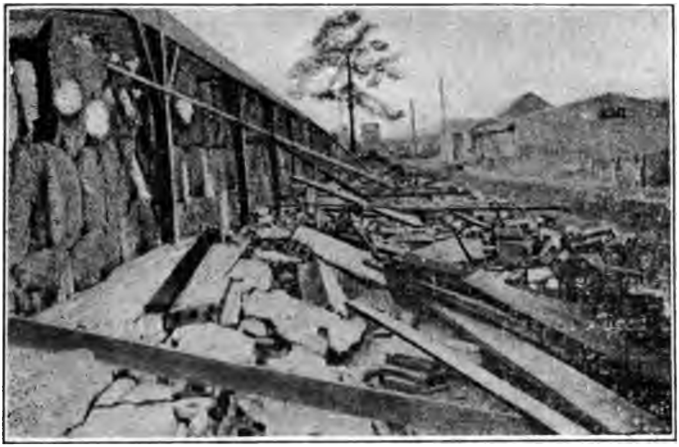
SEMI-SLOW-BURNING CONSTRUCTION

A modified type of slow-burning construction for cotton warehouses is in very general and satisfactory use. This type of building is exactly like the slow-burning construction already described except that the exterior walls are of light frame and the division fire walls are modified in such manner as to form an effective fire break in these inflammable exterior walls. Also the omission of the durable top floor and water-proof paper over the heavy planking is permissible and in keeping with the cheapness of this construction. This combination may be called semi-slow-burning construction. It is frequently spoken of as "wood-end" construction, though this is a rather indefinite term. The value of the semi-slow-burning construction lies in the economical restriction of cotton subject to a single fire. Provided the design of the division fire wall and the wood end is correct, this construction is very satisfactory for buildings properly separated and not seriously exposed to other fire hazard. This design is especially economical of construction in communities where lumber is readily available and masonry materials are scarce.

The exterior walls constructed of light frame afford advantages in some cases to firemen, since the boards can be pulled off readily, thus providing openings through which hose streams may be played effectively upon the fire. The disadvantage of the wood-end wall is that it does not afford adequate protection from fires of exterior origin. Therefore, these two considerations are favorable to the use of very light framing, such as 2 to 4 inch studding, carrying lapped siding, or weatherboarding, combined with heavy posts that support the timbers carrying the floor or roof plank. Thus, if the fire gains sufficient headway to make destruction of the light inclosure necessary it may be accomplished easily; or, in the event of the fire having made dangerous progress, the light inclosure may be burned away and still leave the roof or floor adequately supported for a time. The siding should be applied horizontally and with edges of boards well lapped so as not to permit the entrance of sparks. Vertical boarding is less desirable unless the joints between planks are well stripped. Siding may be the ordinary resawed beveled weatherboarding, either sized or dressed. The dressed material is to be preferred unless the wall is to be whitewashed, in which event the rough material affords a better surface for the whitewash. This frame wall may be left unfinished or it may be whitewashed, stained, or painted. Whitewash affords good protection against attack of flame, but the result is unsightly unless the mixture is colored and frequent applications are made. Stains made with creosote may be used, or the wall may be painted with such paints as do not burn readily.

Clay wall tile may be used as a substitute for the frame wall of single-story buildings. The thickness of tile need be only 6 or 8 inches, provided it is suitably tied or braced against wind and guarded from the piling of cotton bales against it. These precautions are absolutely essential. Clay tile may be used satisfactorily for thin walls, provided the wall is sufficiently braced by pilasters or other device. The wall should be built independently and outside of framing supporting the roof. This reduces the extent of possible wind damage, permits ready breaking through in case of fire and lends itself to economy and efficiency in original construction. Such a wall is economical in upkeep and affords far less spark and exterior fire hazard than the wood end. This type of wall may be termed a paneled tile curtain wall.

Doors and windows for either the wood or tile wall should be provided in the manner described for masonry walls for slow-burning construction, except that there is never any occasion for doors to be tin covered. It is best that windows be glazed with wire glass in order to reduce breakage. There is no objection to omitting windows entirely so far as dealing with fire is concerned, as either type of wall can be broken through readily. Steel sash are economical when upkeep is considered, even when used in a frame wall, but wood sash may be used if desired.



TILE WALL WRECKED BY WIND

FRAME CONSTRUCTION

Frame construction for the cotton warehouse may be used in some cases. Such buildings should not be of the ordinary joisted construction, with very light rafters and thin sheeting. The roof should be of the same construction as that described for semi-slow-burning, and the walls should be the same as those used for the "wood end." It is essential that such buildings be well separated, a distance of 100 feet being required between each building and any other building. Such an arrangement generally is not economical except in case of very low value of real estate. The cost of yard hydrant piping is increased very much by this necessary scattering of buildings.

If conditions warrant the frame construction it is well to arrange the buildings in a straight line in order that possible expansion of capacity may be effected by closing in the intervening space, thus forming additional compartments in such manner as to be divided by fire walls suitably placed. Therefore, it is well to adjust the area and height of the buildings in such manner as to give for them and the future additions the capacity advised for compartments. Like the semi-slow-burning design, one story is most desirable and two low stories should not be exceeded. Where two stories are used, an inclined runway, or platform, may be provided in order that cotton may be trucked to the higher level.

The construction of the roof—and floor, if there is an intermediate, or second, floor—should be of the heavy slow-burning type as this will greatly facilitate the extinguishment of fire and limit extent to damage. Moreover, such construction is but little more expensive than the light frame construction when the element of labor cost is considered.

"IRON-CLAD" CONSTRUCTION

The type of construction commonly known as "iron-clad," or the warehouse built of a light wood frame having sides and roof covered with sheet iron, fulfills its greatest usefulness in the case of isolated small warehouses and is used largely on account of the economy with which it can be constructed. This construction is practically proof against exposure to sparks. However, the thin metal affords but little protection against heat to the framing and therefore the spacing of the buildings with reference to each other and surrounding exposures should be the same as is recommended for the frame warehouse.

ELECTRICITY EXPLAINED IN SIMPLE TERMS FOR THE FIRE INSURANCE MAN

Some of the Most Common Hazards Considered From the Underwriter's Viewpoint

By S. T. Skirrow, Insurance Engineer

"What is electricity?" was asked of Jones by the professor while a class in electricity was in session. Jones, who was day-dreaming at the time, heard the question but became confused and replied, "Professor, I did know but I forgot." "What a great loss to science," said the Professor. "The only man who knows what electricity is and he has forgotten!"

We know what electricity will do, how it acts under certain conditions, how to measure it and how to make it, but we have not yet been able to find out what it is.

Every fire insurance inspector ought to have some knowledge of electricity. He, at least, ought to know how it is produced and how it acts so that he can more easily understand and find its hazards.

Usually, electricity is considered as being composed of two conditions—positive and negative—which, when separated, have an affinity for each other that tends to bring them together in even quantities and thereby establish a neutral condition. A charge of electricity may be produced in several ways; one of the simplest being by "friction." If a piece of coarse paper is rubbed against carpet, it will be found that the piece of paper will, if placed against the wall, adhere to it for a short time. Rubbing the paper and carpet together separate the positive and negative conditions in each and transfers the conditions so that the paper becomes all negative and the carpet all positive. We say the paper is electrified negatively and the carpet positively. When the paper is placed against the wall, it attracts negative conditions from the heretofore neutral wall with the result that the mutual attraction of these negative and positive conditions holds the paper against the wall. After a short time there is a transference of negative and positive conditions between the paper and the wall, both again becoming neutral, and the paper falls because there is no longer attraction. This, I hope, makes clear the action of the positive and negative conditions.

Electrical conditions may also be established by scuffing one's feet on a heavy carpet and then holding a finger close to a radiator, chandelier or other object. A spark will pass from the finger to the object. When electricity thus passes from one object to another, we refer to its passage as "flow" or "current." When electricity is stationary, it is called a "charge." This may be likened to water flowing through a pipe or water in a tank.

The three basic factors in connection with the flow of electricity with their synonyms are: Volume, amperes (C) pressure or volts (E), and resistance or ohms (R). If you know the electrical pressure and the electrical resistance of a circuit you can tell the amount of current that is flowing. Similarly, if you know the pressure (volts) and the amount of current (amperes) you can tell what the resistance (ohms) is. You can also tell what the pressure is when you know the amount of current and the resistance. The simple rule for this (known as Ohms' Law) is that amperes equals volts divided by ohms. Ohms equals volts divided by amperes, and volts equals amperes multiplied by ohms. To measure the power used in a circuit, multiply the amperes by the volts. Thus 50 amperes × 100 volts gives 5,000 watts. This is expressed 5 Kilowatts or 5 K.W. (Kilo is Greek for 1,000.) Note: 746 Watts equals one horsepower.

HOW PRODUCED

Electricity is produced in several ways. The following briefly gives some of the methods:

WET BATTERY: A simple form of wet battery is composed of a zinc and a copper plate, separated from each other and set in a jar of sulphuric acid diluted with water. When the two plates of this battery are connected outside the liquid a current will flow on account of a chemical action and bubbles will be seen leaving the zinc and forming on the copper. In time, the copper would be entirely covered with these bubbles and would become what is called "polarized," thereby making the battery dead. Large carbon cylinders are, therefore, used instead of copper plates to dissipate the bubbles and prolong the life of the battery.

GRAVITY CELL: A gravity cell (so called) has a copper plate and blue vitriol (copper sulphate) on the bottom of the cell and a zinc plate at the top. Polarization in this form of a battery is prevented by the action of chemicals used and gravity.

STORAGE BATTERY: A storage battery (so called) is composed of lead plates immersed in diluted sulphuric acid. An electric current passed through the plates and the solution (which is known as the electrolyte) causes a chemical change in the lead. When the plates reach such a condition that no further chemical action results, the battery is said to be fully charged. If the charging current is now removed and a connecting wire placed between the plates of the battery, a current will pass through it until the plates resume their original chemical condition and the battery is then said to be discharged.

DRY CELL: The principle of the dry cell is the same as the wet cell except that the container is of zinc, and constitutes one pole of the battery, and a stick of carbon is placed in the center of it for the other pole. Between these there is packed a moist chemical. The battery becomes polarized in a relatively short time even though not used. Such batteries are suitable for intermittent use only.

DYNAMOS: Before explaining how electricity is produced by a dynamo, a few words should be said about magnets. A natural magnet exists in the form of an iron ore called lodestone. This has the property of attracting iron or steel. Artificial magnets are made from tempered steel. They are often bent in the form of a horse-shoe so as to get the effect of both ends or poles upon the same piece of iron. Electro magnets are made of iron about which an insulated wire is wound. The passing of a current of electricity through this wire causes the iron to become magnetized. Between the poles of a magnet which are known as North and South, there are lines of force. Dynamos are made of electro-magnets so arranged that in the space between the poles (where the lines of force exist) a shaft is rotated on which there are mounted coils of wire, each coil having its terminals in a commutator or switching device which is placed at one end of the shaft. The rotation of the coils of wire of the armature cuts the lines of force. This produces an electric current in each coil which is picked up in succession by brushes resting on the commutator. The voltage produced varies according to the speed of the rotation, the strength of the magnets and the number of turns in the armature coils. The quantity produced depends on the size of wire and the speed of rotations.

ALTERNATING AND DIRECT CURRENT

Contrary to the opinion sometimes expressed, alternating current is more dangerous, or rather more treacherous to work with than the direct current.

The difference between alternating current and direct current originates in the manner of its being picked up in the dynamo. Direct current is picked up by brushes resting on a commutator, and the current produced is a series of what we might term little "pushes" in the same direction. Alternating current is picked up by a pair of rings instead of a commutator and because of this the current is reversed at every turn of the armature and we get a series of "pushes and pulls."

Alternating current is used to a much greater extent than direct current because it is easier and cheaper to transmit and distribute. The reason for this is that a wire of a given size will carry only so much current (amperes). A saving is effected by carrying the current on a small wire at low amperage and high voltage, and when it arrives at the place it is to be used, transforming it and thereby reducing the voltage and increasing the amperage as desired. The usual voltage desired for local use is 110 volts.

Alternating current can be transformed as indicated above by stationary transformers, which are in effect large induction coils, with very small loss, whereas direct current must be transformed by motor-generators with great loss.

Direct current is used by many street railways, elevated railroads and subways. The voltage carried by these railways is in the neighborhood of 550 to 600 volts.

CONDUCTORS AND INSULATORS

Almost anything will conduct electricity, but some materials are better conductors than others. Metals are the best conductors. For commercial purposes, copper is almost generally used, although iron sometimes is used for outside wires where the currents carried are very low, such as in telegraph and telephone work.

While it is true that all materials will conduct electricity, some materials are such poor conductors that practically no electricity can be passed through them. They are, therefore, called insulators and are used for that purpose. Among the best insulators are glass, slate, porcelain, rubber, mica and bakelite.

Inspectors should be careful to note the condition of insulation on wires. Insulation of a very poor grade or that which is oil soaked will burn easily, adding fuel to a fire.

SIMILARITY TO WATER

There seems to be a similarity in the electricity flowing on a wire to water flowing in a pipe. When you once fix this firmly in mind, it will be much easier to find and understand the hazards of this great force.

We can create pressure to make water flow by means of a pump. If we had a difference of pressure between one end of the pipe and the other, the water will flow from the point of higher pressure to the point of lower pressure, and when the level of the water becomes the same at both ends of the pipe the flow will stop. We get similar results with electricity, using a wire instead of a pipe, electricity instead of water and a battery or dynamo to make the pressure. Electricity flows, is subject to pressure and the quantity which flows is limited by the size of the wire used to conduct it. The three great factors of electricity have an analogy to water. The amperes (volume) would correspond to a supply tank. The volts (pressure\ would correspond to the pressure of the water derived by the elevation of the tank and the ohms (resistance) would be the resistance offered by the pipes to the flow of the water.

REASON OF WIRE TROUBLE

One very great difference, however, between the flow of water and the flow of electricity is that water flows inside of a pipe while electricity flows on the surface of the wire. Another difference is that only a limited pressure can be carried in a water pipe, whereas a wire will carry any electrical pressure (insulation on wires carrying high voltages is very apt to break down). Further, the quantity of water flowing in a pipe has no effect on it while the volume (amperes) flowing on a wire, if too great, will fuse it.

When an amount of electricity flows over a wire which is too small for it to carry, it tends to heat it and the greater the amount of current that flows, the hotter the wire will become until it reaches the fusing point, when, of course, it will cause the insulation to take fire.

As an illustration, the electric light wires in your house (if there were no fuses) would allow you to draw all of the current you desire, the various lights acting as faucets with a fixed discharge as in a water system. If you draw too much current, it will produce what we might term a strain on the wiring and cause the weakest wire, over which the current flows, to melt, whereas in a water system, opening all of the water faucets in the house would tend to reduce the strain on the water pipes.

WIRING

All wiring should be in accordance with the rules in the National Electric Code. A few words might be said here on the different kinds of wiring.

CONDUIT: This is the very best form of wiring, and is absolutely essential to the safety of certain classes of risks, such as warehouses, garages and hazardous manufacturing buildings, and parts of buildings where hazardous work is carried on. It consists mainly of carrying the insulated wires in metal pipes, which are firmly attached to metal receptacles or boxes to which the lights or switches are fixed.

BX-CABLE is, perhaps, the next best method of wiring. It consists of the two insulated wires covered by flexible metal armor. This wire is also firmly attached to metal receptacles or boxes.

CIRCULAR LOOM: This method is to carry each wire in a tube (similar to a rubber gas pipe hose) of special woven fabrics of insulating value.

KNOB AND TUBE: This is a very common form of open wiring. It consists of carrying each wire on a porcelain knob and in porcelain tubes when passing through partitions. Many receptacles used in connection with this kind of wiring have porcelain bases. This kind of wiring is often found in frame buildings where a finish is not required. It is not desirable, being subject to mechanical injury.

TEMPORARY WIRING is found under scaffolds when decorating is being done in completed buildings or in buildings in the course of construction, and is usually of knob and tube type. Temporary wiring in a building in the course of construction at No. 78-82 Maiden Lane is attributed as the cause of a fire which occurred there on January 26, 1920. In this particular case the wires were bunched and tied together in a decidedly unsafe manner. The excessive current used apparently caused the insulation on the wires to take fire. The wiring should be approved by the local inspection bureau before permission is given to turn on the current.

FUSES

Fuses are the safety valves of an electric system. As a wire of a given size will permit only so much amperage to pass over it, the underwriters require the installation of a fuse in a gap in the system which in effect is a wire which will melt at less amperage than the wire it is designed to protect. It is usual to allow an ample margin of safety as wires are often overloaded by the use of motors, toasters, irons, etc., these devices often being attached to ordinary electric light outlets.

Many fires occur from circuits being overloaded by the installation of new lights or motors, the fuse having blown a larger one which may be of greater capacity than the wire, being inserted. Sometimes pennies or nickels are placed behind the fuses, thus rendering the fuse useless, the current going through the coins instead of the fuse wire. Many times jumpers are installed, and they are equally dangerous, being extra wires placed around the fuse which allow excess currents to get on the line.

LIGHTNING RODS

While looking out of the window during a thunder storm I remember seeing lightning strike a large dairy barn located a few blocks away. The ensuing fire naturally got a quick start, and totally destroyed the barn. If lightning rods had been placed on this barn, I feel sure there would have been no fire. Lightning rods are nothing more than large wires extending above the high parts of roofs of buildings to catch the descending electrical discharge of the lightning. The wires are run in as straight lines as possible to the ground, where they are attached to buried copper plates. Buildings out of fire protection should always be protected with "lightning rods." An article going into this subject more thoroughly appears in the January *Quarterly* of the National Fire Protection Association.

CIRCUITS

Street railways, subways and elevated railroads usually carry 550 to 600 volts; one side (trolley wire or third rail) is positive, and the ground or tracks are in most cases the return or negative. Electric light circuits are usually 110 volts and sometimes 220 volts; when on the line just before being transferred and entering building it is often 2,200 volts or more.

SHORT CIRCUIT is merely a crossed connection enabling a current to find an easier return to its source than the one provided for it. Short circuits on trolley or other power lines are dangerous, but the danger is considerably less from short circuits of telephone or telegraph lines. Short circuits of electric light wires in a building are dangerous, a spark usually occurring where the current jumps from one wire to the other wire, and is apt to set fire to the insulation or other material. The writer witnessed two short circuits of drop cords for trouble lights in garages, both of which started fires, one of which resulted in an almost total loss.

Wires laid on floors or placed on walls where they are liable to injury are very apt to become short-circuited due to such possible injury. Unless B.X. cables are fastened to receptacles with proper bushings or box connectors, the wires are likely to cut where resting on the edge of receptacles and thereby cause a short circuit, a spark and then fire. Fuses will go a great way to prevent fires from short circuits by blowing and cutting off the supply of current. In some cases, however, a short circuit will form a poor connection and not draw enough current to blow a fuse, yet be enough to cause an arc (sparking). Should a trolley or electric light wire fall across other wires leading into a building, a fire is apt to occur. Short circuits often occur by one side of a circuit (the insulation having become worn or breaking away) coming too near a pipe or wire that leads to a ground, such as a water pipe. Short circuits are also apt to occur in damp places; water being a good conductor of electricity is liable to soak the insulation or attack a weak spot.

ELECTROLYSIS

Electrolysis is caused by returning stray currents jumping from one metal in its path to another. The reason that currents jump in this manner is because electricity will always seek the easiest return (the path of lowest resistance) to its source. In the case of street railways or subways the power house is often but a mile from the place where the current is used (trolley or train), and the tracks through which it would ordinarily return, perhaps, have a circuit return of five miles. It is, therefore, less resisting for the current to return by jumping to pipes, etc., which may provide a shorter path. The jumping of the current causes a pitting of the part it leaves and a deposit on the other part. It is dangerous in that the pitting weakens water pipes, structural steel or other places it leaves and may cause collapse. Where such jumping of stray currents is found, the two parts should be bonded with heavy copper wire so that the current will follow the lines of least resistance, passing over the wire instead of through the earth. In Chicago the jumping of stray currents caused a pitting in the steel framework of a building to be so serious that it endangered the structure. "Electrolysis" caused an explosion and fire by pitting a hole in a gas pipe near a building at 131 W. Water street, Chillicothe, Ohio, and at a building on the corner of 6th street and Walnut street, Mansfield, Ohio. In these cases the gas escaped from the pipes and, entering the building, came in contact with an open flame which caused an explosion.

STATIC ELECTRICITY

This is another name for frictional electricity. Where there is machinery in motion (especially heavy duty machinery) a charge of electricity is likely to be produced in the same manner as the electricity was produced with the carpet and the cloth, as explained in the fore-part of this article. One common way in which it is produced is from slipping belts. In some instances, sparks an inch long are discharged from one or the other of these moving parts in an effort to establish a neutral condition. On account of this sparking, static electricity is a source of great danger, especially in buildings where there is apt to be an explosive vapor or dust. This is particularly true of sugar refineries, starch factories, feed mills, flour, rice, corn and other mills, benzine cleaning establishments and ribbon sizing factories. The remedy is to connect the part producing the positive element and the negative part with heavy copper wires or connect these parts to the ground. If the positive part is a belt, a brush could lay against the belt and connect to a ground.

Many explosions have occurred from ignition or smut dust in threshing machines. The chief source of ignition of such explosions is by static or frictional electricity produced by rubbing of metallic parts or slipping of belts, or possibly from the rubbing of the grain against the metal surface of the machine. To rid the machine of this electricity, it should be effectively grounded, thereby passing off the current to the ground. It would also be desirable to connect all movable parts with each other and then lead to a common ground, thereby destroying the difference of potential within the machinery.

Of a given candle power, carbon bulbs use the most current. Tungsten bulbs come next and nitrogen bulbs use the least amount. This is due to the fact that more resistance is offered current by a carbon filament than is presented by the metal filament in the tungsten bulb. Nitrogen bulbs use less, due to the fact that the filament is surrounded by nitrogen gas instead of vacuum as in the other bulbs. This gas has a peculiar property of lessening the resistance of the flow of current.

Broken snap switches, key sockets or bushings (where wires enter receptacles) are apt to cause short circuits. The use of alternating current devices on direct current, or direct current devices on alternating current, is also liable to cause short circuits and blow out fuses. Knots in electric light cords or cords hung over nails are liable to cause short circuits. The use of long drop cords is bad practice. Their lengths should be limited to 10 feet, and if a 10 foot cord will not reach where needed, another fixture should be provided at a convenient location. Cords should not be carried through doorways or placed where they would be subject to mechanical injury. They should be made of stranded wire, be well insulated and have a durable covering. A poorly covered cord is easily injured, becoming liable to short circuit.

Open wiring should be spaced 2½ inches apart and should be securely fastened to knobs and not allowed to sag and rest near or against walls, beams or ceilings. Where open wires cross each other, one of the wires should be protected with a porcelain or other approved sleeve.

The Electric Code requires that wires where joined together be twisted and soldered, covered with a rubber tape, and then a cotton tape. Where the joints have been taped, it is impracticable for the ordinary inspector to see if joints have been properly made, but it would be well for the ordinary inspector to note if the joints are firm and neat, as this would indicate to some degree the condition which is covered.

B. X. cable should be firmly fastened to receptacles or boxes by box connectors or bushings, otherwise the weight of the wire will draw the metal covering back and allow the wires to rest on the edge of the box or reecptacle and cut the insulation, causing a short circuit.

Fuses should be enclosed in metal boxes so that if they melt the hot metal will be prevented from coming in contact with inflammable material.

Wires carrying electric light or power current should not pass over buildings. They should be carried around buildings, underground or on suitable poles.

Bulbs should not rest against combustible material or have paper, cloth, celluloid or other combustible shades.

Particular attention should be paid to old wiring to see that it is not exposed to abrasion, that it is effectively grounded to metal water pipes leading to the earth, or other equally good ground.

Wires in damp places should be properly safe-guarded against short circuiting from water soaked insulation. In such places, it would be desirable to have the wires in conduit with marine fittings.

Most electric toasters and irons use 660 watts, which is considerably more than the amount an ordinary socket will stand. If these devices are attached to an ordinary socket, it would only be a short time before the insulation in the socket breaks down. Special sockets should be provided for electric toasters, irons, sewing machines, electric washers, curlers, etc. The use of cheap toasters are dangerous, many fires having resulted from the short circuits common to them.

Conduits or pipes on the outside of a building in which wires are led into building should be bent to prevent water entering them and should also be provided with a standard fitting to prevent chafing of the wires.

Starting boxes of motors should be kept free from dirt and dust. Where it is necessary to have motors in dirty places, they should be enclosed in metal. If the premises are dusty, only dust-proof motors should be used. These motors are so enclosed that no spark from them can ignite dust and thereby cause an explosion. Starting handles should not be tied fast with strings or wire or jammed with paper or wood blocks. If current is turned on when handle is tide in place, arcing in the motor is apt to occur.

Motors or dynamos located under sprinkler heads or where water is apt to splash on them should be protected with suitable shields. When motors spark, it is an indication that the brushes are set at an improper angle or the commutator is covered with dirt or dust.

Rooms containing many storage batteries should have proper ventilation. The fumes given off by them, if confined, is apt to cause an explosion. Such explosions have occurred on board United States submarines and recently in a street car battery service station in Miami, Fla. Hazardous rooms should be provided with wire in conduit with marine fittings, vapor-proof globes and keyless sockets. The switches controlling this equipment should be placed outside of the room. In garages, they should be at least 5 feet above floor.

The 30-volt generator and battery systems found in many country places, which electric light and power lines have not reached, require special wiring. It is not safe to use, on such equipments, the wires, cords and fittings which are suitable for the 110 volt system. These equipments operate at 30 volts instead of 110 and therefore require a greater volume of amperes and the wiring and fixtures should be large enough to prevent overheating and fusing.

SUSCEPTIBILITY OF EQUIPMENT

Practically all electric apparatus is very susceptible to damage from fire and water. The following may be of interest in connection with the hazards and susceptibility of certain electrical instruments:

Condenser is an instrument for storing temporarily a quantity of current. It is generally used on low currents. Presents no great hazard, but is very susceptible on account of its delicate make-up.

Dentists Electric Panel Boards are susceptible. Currents used are low and if properly set, allowing a clear space from combustible material, there is very little hazard. Cauterizing point should not be allowed to come in contact with combustible material. This is a platinum point which is heated to red heat.

Galvanometer used for detecting a balance of stationary current in a line. Very susceptible.

Motors are similar to dynamos. In fact, some can be used as either a dynamo or a motor, but the best results from each are obtained when they are used for the purpose for which they are made. They are machines that rotate a shaft when electric current is applied to the machine. In an electric motor, wire is wound on an iron core which is free to rotate on a shaft which is set between the poles of a horseshoe magnet. "Universal motors," so called, are designed so that they will operate on either an alternating current or a direct current. They are usually of small size and are used for fans, sewing machines, etc.; seldom made in large sizes as they are not efficient.

Motor-Generator—A combination of a motor and a dynamo is convenient for converting certain voltages of direct current to other desired voltages, as for instance, the existing direct current is 110 volts and it is desired to convert it into 375 volts. The amount and kind of wire used in the coils on the armature determines the voltage.

Rectifiers are used for properly applying current in the charging of storage batteries. Very susceptible to damage from fire and water.

Rheostats are used for regulating motors and controlling the flow of current. Consist of a box of coils of wire for resistance. Speed of motors can be regulated and voltage thereby controlled.

Some rheostats have a fixed resistance and are used for stereopticon, moving picture machines, etc. Their purpose is to reduce the voltage from the supply, usually 110 volts, to that required for the apparatus used. A rheostat, used in connection with a stereopticon left turned on, started a fire in nearby woodwork.

Spark Coils—Coils of wire so wound as to produce a very high voltage so as to induce a current to jump a gap and thereby make a spark. Usually found in connection with low currents on automobiles and motor boats and gas lighting apparatus. No hazard. Very susceptible.

Transformers are used to transform certain voltages or alternating current to other desired voltages. This is done by mounting two coils of wires on an iron core, side by each and passing the current through one coil. A current will be induced with very small loss in the second coil and the voltages are altered by the amount or proportion of wire in each coil. Where high voltages are handled, there is great danger of short circuits causing fires. In case of fire, the damage is apt to be very severe on account of the susceptibility, water soaking insulation of coils, etc., making them dangerous for further use. You often see transformer stations in the country, in large plants, on electric light poles, and they are often placed in the man-holes for electric light conduit. The "toy" transformer steps 110 volts down. It should be well designed and as foolproof as possible. The transformer case should be made so that children cannot easily take it apart without destroying or breaking it. Those having a sealing compound present a less fire hazard. Those having switch on side are apt to short circuit sooner than those having the switch on top.

Wireless Telephone and Telegraph Instruments—The small installations found in private residences, carry but little current, but at large stations where long distance work is done, the currents are high. All apparatus is very susceptible to damage from fire and water.

X-Ray equipment is very susceptible to damage from fire and water.

SPECIAL RISKS

A few words might be added about the requirements in certain classes of risk:

Chemical Works—The action of certain acids, such as nitric and sulphuric, causes decomposition of all exposed metal-work in their presence. In a chemical plant, electric wiring should be insulated covered wire on porcelain, placed 4 inches apart and arranged to be not nearer than 1 inch to the ceiling. This system has been used in certain plants, but it is found necessary to replace certain portions of the wiring every one or two years. Lead wires have also been used with success, but are apt to cause trouble at the socket of the lamp where attached to the wire.

Electric Light and Power Stations or Transformers and Switching Stations—A recent report in a quarterly of the National Fire Protection Association shows that the most common causes of fires in this class are from lightning and boilers, especially the stacks of the latter (see sketch). The chief hazard of transformer stations is the escaping oil from a switch, lightning arrestor or transformer case, becoming ignited either by electric arcs within the tank or case or by contact with a heated surface (surface fire, electric heaters, etc.) after leaving the case. Heavy duty switches that operate frequently under load constitute a greater hazard than oil immersed transformers or electrolytic type lightning arrestors. Transformer oil itself must be raised to about 400 deg. F. before it would ordinarily take fire. There is also danger from explosion by a spark of the vapor given off by hot oil when mixed with a proper proportion of air. There should be no frame work about the transformers and switchboards and transformers should not be on wood floors. Lightning arrestors should not be on frame supports. The oil, transformer and battery rooms should be divided from the generating room by a standard fire wall with openings protected each side by standard fire doors. Tarpaulins should be provided for each motor and kept on the motors when not in use. Balconies should be of fireproof construction, and there should be no wire towers on repair shop in the building. The rear of switchboards should be kept clear of rubbish.

Garages—All wiring should be in conduit with keyless sockets. Switch boxes should be located where there is no danger from explosive vapors.

Grain Elevators—Wiring should also be in conduit with keyless sockets and marine fixtures. Dust accumulating on an ordinary globe has been known to cause fires. Switch boxes should be located outside or in a special room where there is no dust.

Telegraph and Telephone Stations—Very low currents used, usually not more than one-tenth of an ampere and 375 volts. Instruments are very susceptible, particularly switchboards. Main offices are open all the time.

Warehouses—Only conduit wiring should be permitted. Rows of lights are only permitted above aisle spaces; keyless sockets, also guards to protect globes, are required. Cut-out boxes, each floor, should have self-closing doors and a pilot light should be attached to main switch box which must be located on first floor, near the main exit. This is to remind the warehouseman to turn off all lights when leaving the building.

EXTINGUISHING ELECTRIC FIRES

Extinguishing electric fires is sometimes difficult and nearly always dangerous. Current in the building should be turned off immediately by opening the main switch; then almost any method of fire extinguishment may be used. If the current is not turned off, it is exceedingly dangerous to pour water on most electric fires as a severe shock is apt to be received by the person pouring the water, the current following the water, which is a conductor, back to the individual. The action is somewhat similar to the effect produced by pouring a pail full of gasoline on an open flame. The only safe method is to use sand, earth, or an extinguisher using carbon tetrachloride. Water from a hose stream or chemical extinguisher can sometimes safely be applied at distances, say, 20 feet or more.

THEATRE HAZARDS AND FIRES

Over Five Hundred Theatres Burned in One Hundred Years—Historic Catastrophes—Causes and Effects Described

By C. C. Dominge, Insurance Engineer, New York City.

(Twelve years ago Mr. Dominge contributed an authoritative article on theatre fires to this paper which appeared in the first volume of "Live Articles on Special Hazards." The present address was delivered before the Clerks' Association of the Springfield Fire and Marine at the home office and brings his former material down to date, with much interesting elaboration.—EDITOR.)

It will be necessary at the start to relate a little of the past history of the fire record of theatres. In 100 years over 500 theatres have been destroyed by fire throughout the world, and nearly three times this number are recorded where slight fires or alarms have taken place. From the middle of the last century up to a short time ago, an average of twenty theatres each year have been damaged by fire. In the years from 1881 to 1885, 175 fires are recorded. We find that thirty-seven theatres were burned twice, eight three times, four four times, while the old Bowery Theatre on the Bowery, New York City, has burned five times.

OLD DRURY LANE

Theatrical history tells us that owing to the very poor fire record of theatres, when the Drury Lane Theatre in London was torn down in 1791 and a greater and better building erected, the management, on the opening night, had one of the most famous actresses of the time (a Miss Farren) step before the footlights and recite the following lines accompanied by unique stage "effects":

The very ravages of fire we scout,
For we have wherewithal to put it out,
In ample Reservoirs and firm reliance
Whose streams set Conflagration at defiance.
Panic alone avoid; let none begin it—
Should the flame spread, sit still; there's nothing in it—
We'll undertake to drown you all in half a minute.
Behold obedient to the prompter's bell

Our tide shall flow and real waters swell.
No river of meandering pasteboard made,
No gentle tinkling of tin cascade,
No brook of broadcloth shall be set in motion,
No ships be wrecked upon the wooden ocean;
But the pure element in its course shall hold,
Rush on the Scene and o'er our Stage be rolled.

At this point the curtain rose revealing water from tanks on the roof cascading over artificial rocks into a huge basin. Pointing to the tumbling torrent the actress spoke on:

How like you our aquatics—need we fear
Some critic with a Hydrophobia here,
Whose timid caution Caution's self might tire,
And doubts if water can extinguish fire?
If such there be, still let him rest secure,
For we have made Assurance doubly sure.
Consume the scenes, your safety yet is certain.
Presto! for proof let down the Iron Curtain.

Then another pause while an iron "fire" curtain was lowered. To convince the audience that there was no deception it was banged upon with hammers.

However, the theatre burned to the ground fifteen years later—automatic sprinklers were not then available for the proper utilization of the "wherewithal" spoken of in the prologue.

William Paul Gerhard in his book, "Theatre Fires and Panics," states that 19.4 per cent. of the fires in theatres took place between 7 A. M. and 1 P. M., 5.2 per cent. one hour before beginning of the performance, 12.4 per cent. during the performance, 23.9 per cent. within two hours after the closing of the performance, 39.1 per cent. during the night and before 7 A. M. the next morning. It will be seen from these figures that the greatest danger from fire to a theatre is during the two hours following a performance, and not during the performance, as would naturally be supposed. The reason for this is that during the performance extra precautions are taken and a uniformed fireman is right on the job. Just as soon as the final curtain is lowered, however, everybody is anxious to get away, the lights are quickly extinguished and it is at *this time* when a tossed lighted cigarette or a match gets in its fine work among the "dry as tinder" stage props or highly inflammable scenery. Theatres are, therefore, safest in the day time. The danger is increased threefold during the preparations immediately before the performance on account of lighting up, making ready, etc. It is reduced during the performance on account of careful inspection and watchfulness, but the danger reaches a maximum (seven times the day risk) during the two hours directly after the close of the performance.

CAUSES OF FIRES

The causes of some of the most prominent theatre fire calamities may not be out of order at this point:

Cementing moving picture film in booth.

Careless hoisting of a stage chandelier containing lighted candles which ignite a scenery border.

Stage oil lamp igniting roof.

The upsetting of kerosene lamp on the stage.

Careless lighting of the gas footlights igniting the curtain draperies.

A rocket (part of fire-works displayed on stage) igniting the scenic decorations.

In lighting the border lights an explosion of gas took place, igniting the scenic decorations.

Upsetting of an alcohol stove (in dressing room) used for makeup.

In the Brooklyn Theatre fire on December 5, 1876, nearly 300 persons lost their lives when in the boathouse scene from "The Two Orphans," one of the flimsy flies was violently blown against an open gas jet and caught fire. An attempt was made by the stagehands to cut down the burning fly (or canvas scenery). It fell on the canvas roof of the boathouse and in a short time the whole building was in flames, being aggravated by the opening of the large door (used for bringing in scenery) in the rear of the stage. This open door let in a blast of air which drove the flames, hot gases and the suffocating smoke through the proscenium opening into the auditorium, finally venting itself into the open space directly over the large central gas chandelier, which was hung from the trusses of the auditorium roof.

HISTORIC DISASTERS

During a matinee performance on December 30, 1903, while the spectacular play called "Bluebeard" was being given, a fire said to have started by a border scene coming in contact with an electric arc light, badly damaged the newly constructed Iroquois Theatre in Chicago. This theatre was up-to-date and of fire resistive construction. When this performance was given a number of the details were probably incomplete, as it is claimed the stage roof vents and the fire curtain were inoperative. The automatic attachments to the ventilator were not in place and the skylights were nailed up by outside timbers. The asbestos fire curtain was rendered useless by an interfering swinging bracket (used to carry lights for scenic effects) which so swung out from the stage side of the proscenium wall as to block the curtain when part way down.

The morning following this disaster, in which 573 persons, mostly women and little children, lost their lives, a citizen of Chicago who had lost some of his dear ones asked the well-known fire protection engineer, Mr. John R. Freeman, to investigate and report on means for rendering such fearful disasters impossible. Mr. Freeman's conclusions, briefly summed up, are as follows:

"In the great theatre fires of history, the loss of life has commonly resulted from the rapid spread of flame on a stage covered with scenery, followed within two or three minutes by an outpouring of suffocating smoke through the proscenium arch into the top of the auditorium before those in the gallery could escape. Death has come chiefly to those in the balconies, and often within less than five minutes of the first flame."

The three great safeguards are found to be:

1. The providing of ample, automatic, quick opening smoke vents over the stage.
2. The thorough equipment of the stage with automatic sprinklers, by means of which the action of the heat will promptly release, over the burning scenery, a rain-fall tenfold heavier than the heaviest thunder shower, drenching the scenery and extinguishing the flames.
3. The providing of especially ample exits and stairways from the gallery.

The above summary is extracted from Mr. Freeman's splendid work, entitled "On the Safeguarding of Life in Theatres," and you will notice that his conclusions apply chiefly to the saving of life, a topic of vital importance to us all. I would like to have something to say about this subject, but my efforts tonight are intended to treat the topic from another angle; in other words, to bring out construction features and fire hazards in order to enable the insurance inspector to make an intelligent survey and the underwriter to pass on the merits of the risk.

FIREPROOF THEATRES

In the metropolitan district of New York City we have 180 full-fledged fireproof theatres and forty non-fireproof theatres. We have probably three times this number of buildings where occasionally theatrical performances and amateur dramatics are given. A theatre building contains practically the same hazards whether located in New York or Alaska, and although the following features of construction and the hazards apply to theatres as I have found them in our greater city and its environs, I feel they will apply to any part of the globe where a theatre building exists. The *old style* non-fireproof theatre with its wood beam roof, floors, galleries, boxes, wooden proscenium wall, frame partitioned dressing rooms, work rooms and its gas lighting apparatus is an obsolete type in as far as our up-to-date methods of theatre construction and equipment are concerned, although many of this poor type still exist, especially in small towns. Any attempt to try and improve on this type of combustible interior would be wasted time, because it cannot be accomplished, the hazards being too great, unless it were possible to install a standard automatic sprinkler equipment throughout every portion of the building—stage, auditorium, dressing rooms, etc. Now, let us imagine that we are all in an architect's office with a set of blue prints and specifications calling for the erection of a *fire resistive* theatre building before us, and I shall assume the responsibility of being the insurance engineer sent by the insurance company to criticise the plans in order to produce the lowest possible rate and hazard after the structure is completed. The rate is the best guide, as it penalizes faulty construction and unsafe fire hazards.

The safety of a theatre depends upon six cardinal features; that is, (1) the site, (2) the plan or layout, (3) the construction, (4) the interior equipment, arrangement and fire appliances, (5) the management and class of patrons, and (6) the periodical inspections.

LOCATION OF THEATRES

The site or location of a building is very important as regards its relation to adjoining buildings and as regards the approaches, entrances and exits. The ideal theatre should be isolated, i.e., located on a square or block with a street not less than 100 feet wide on all sides. Of course, this is impracticable, especially in a large city where realty values are so enormous. We must, therefore, be satisfied with a court of 10 feet to 15 feet in width leading directly to the street. (Mr. Dominge then showed a blue print of a theatre in the front facing a street 100 feet wide with only dwellings on the opposite side, while on the right and left sides, are small one-story business buildings. We, therefore, make a notation on the blue print so that all window openings are protected by self-closing wired glass in hollow metal frames and the doorways protected by metal clad lock jointed doors. In the rear at a distance of 25 feet we notice there is a three-story brick rag and waste paper warehouse with ordinary windows facing a small window and a doorway in the rear of the stage building. This is a very serious exposure to the theatre building, but we largely overcome the same by protecting the window and door as suggested above. We would like to have wired glass windows installed in the exposing paper box factory, but we cannot control this building. A fire wall between our risk and the exposures would be a good recommendation, but a very expensive one on account of the height of the stage building.)

THEATRE PLANS

The planning or layout of a theatre consists of the arrangement of the floor plans of the building and of the various parts of the same with their principal horizontal and vertical subdivisions by fire walls and means of communication, such as stairways, entrances and exits.

At this time I want my audience to understand that a theatre building is divided into two principal divisions—the section *before* the curtain, being known as the auditorium, and the section *behind* the curtain, known as the stage, dressing room and work shop buildings. The auditorium section may also be subdivided into the entrance section or office building, in which are found not only the theatre offices, but also retail stores. No special hazards of note are to be found in this portion of the theatre, with the possible exception of the moving picture booth. The division between the two sections is known as the proscenium wall, of which we will talk later. If this wall is properly protected a serious fire may take place in either section without necessarily causing damage to the section in which the fire has not originated.

Fire walls should separate the stage from the auditorium, the dressing rooms from the stage, auditorium from office building, stage from scene dock, carpenter shop, electrician's shop and boiler room. In fact, every section or room communicating with the stage building should be a separate fire risk, cut off by fire walls with approved self-closing fire doors at each opening. (Plans shown by Mr. Dominge.) The plans before us show a part of the dressing rooms under the stage. Immediately we correct this by removing them outside of the stage building and cutting off by a standard fire wall with an approved automatic fire door at the communicating opening. Again we find on one side of the stage a small terra cotta enclosed room with a plaster board roof, used by the electrician for the storage of electric signs and for repairs to the electrical equipment. We must alter this arrangement by placing this room outside of the stage building, the same as we did in the case of the dressing rooms, or, if this is not feasible, make this entire compartment a fireproof vault, i.e., on the side walls common brick, the ceiling common brick or concrete on steel beams and the opening protected by an automatic fire door. On the top floor of the dressing room section the plan shows a trunk room with an unprotected opening. This opening must be protected with a self-closing, lock-jointed fire door. Now comes the proscenium wall which is the wall dividing the stage building from the auditorium. You will remember that I mentioned this wall a few minutes ago. The first thing we find is that the wall is only terra cotta in the section behind the auditorium boxes and that it is open to the roof space over the auditorium. Part of the wall is out under the stage, the same being offset in the musicians' pit enclosure. Several steam pipes and a large metal ventilating duct also pierce this wall. There is an opening behind the boxes on the first floor and in one of the upper boxes protected by a kalamein door. A number of important changes are necessary in order to bring this wall up to the standard. A standard proscenium wall should be constructed of common brick or concrete not less than 12 inches thick and should extend the entire width of the theatre. It should start at the foundation and continue to a height at least 4 feet above the highest section. Preferably there should not be more than two openings either leading to the musicians' pit or on the first floor to the boxes. It is undesirable to have any openings above the first floor. The openings to the musicians' pit or to the boxes should be protected by automatic lock-jointed, standard fire doors. *What must we do then to correct this proscenium wall?* First, substitute common brick for the terra cotta section in back of the boxes. Second, brick up solid and bond the opening to the auditorium roof space. Third, make the wall under stage on a direct line with that above the stage instead of having it at an offset, and brick up and bond the opening to the upper box and substitute two standard fire doors in place of the kalamein door to the lower box; one of these doors to be placed on each side of the wall. Reduce openings around steam pipes to a minimum and remove the metal vent duct, or place an automatic damper on each side of the wall.

BUILDING CONSTRUCTION

The construction of the building is to be considered in reference to the employment of fire resisting materials in general and also in detail, in regard to the construction of the stage and its accessories, auditorium and tiers, dressing rooms, work shop, roofs, aisles, staircases, passages, corridors, doors, entrances and exits. This blue print shows the entire structure to be of fire resistive construction. All the outer walls are of common brick, while all dividing fire walls are of the same construction. Steel beams span the roofs and floors, stage, gridiron and fly galleries, while the arches are filled in with reinforced concrete. I see little to suggest on the plans except that all steel work, including the steel girder over the proscenium opening, should be protected by concrete or terra cotta. The gridiron is the one exception as far as protection is concerned. Steel or iron work, if unprotected, will twist or buckle in a very hot fire. Some of our latest theatre buildings have the stage and auditorium roof members unprotected. The only combustible material we find in the construction of the building before us is the working part of the stage and the enclosure to the musicians' pit and the gallery and balcony stepping. All wood work, excepting that in the working part of the stage, if absolutely necessary, should be laid without air space.

INTERIOR EQUIPMENT ARRANGENENT

This includes many important details, such as the *fireproof curtain,* the stage scenery and the stage machinery, the fly galleries, rigging loft or gridiron, painters' bridge, *the stage roof ventilator,* the heating, ventilation, lighting, plumbing, drainage, sanitation, water supply, *fire extinguishing appliances,* lightning rods, fire escapes, doors, auditorium chairs, moving picture booth and the life-saving appliances. The moving picture machine should be segregated in a brick or reinforced concrete room with access to same from outside of building only and have one-quarter (¼) inch automatic boiler iron traps at peep and projecting holes into the building. What we usually find, however, is a booth constructed of very light sheet metal or plaster blocks without proper ventilation, traps or fire doors and with the repairing and rewinding of films done in the same compartment. Three vitally important items in this list interest the underwriter.

Before we proceed with these items it may be well to mention the several stage construction features which are necessary for producing a play. The center part of the stage which is visible from the auditorium is called the working part, and is constructed of wood, so that it can be lowered or altered to permit of traps, tanks, etc.

On each side of the stage at an elevation of say 20 feet is the fly gallery, where the stagehands operate the scenery, ropes, etc.

In the rear connecting the fly gallery is the bridge, merely for access from one side to the other.

Directly under the roof, possibly 6 feet below same, is the gridiron or rigging loft. On this slatted iron frame are fastened the necessary hardware to which the scenery is attached.

The stage roof ventilator in the blue print is not large enough to properly vent this roof. It should occupy at least one-eighth of the stage area. Several types of ventilators or skylights are on the market. One type, known as the "Monitor," is a large metal affair, with metal sides hinged off center. In the case of skylights they are of the sliding type, which have thin glass on metal supported by brass wheels running on an inclined metal track, the movable parts of the above devices to be held closed by cords running to an iron triangle and thence by one single rope to the stage with a sign reading "Cut the Rope" nearby. A good steel knife fits in a slot where the sign is nailed to the wall. If a fire should break out on a stage (and it is a hundred to one that it will start here) if the skylight or vent rope is cut or burned the ventilating apparatus will open and quickly allow the heavy suffocating smoke and gases to escape. (A properly constructed stage building with vented roof is not unlike the boiling building of a varnish plant.) A number of ingenious patterns are on the market for ventilating stage roofs, one in particular consisting of a large boiler iron flue with a valve inside made of a wooden frame covered with canvas, which is kept closed by a balance weight. A wire cable connection is carried down from the valve to each side of the stage, while other cables are carried to points in the auditorium. By pulling any of the cables the valve is opened, and at the same time a simple contrivance closes simultaneously the ventilating outlet over the auditorium, thus reversing the usual movement of air from the stage to the auditorium ventilator. Should the cable not be worked in time, the valve being of canvas is readily destroyed by fire and the smoke outlet in the stage is thereby opened.

FIRE CURTAINS

The fire curtain, usually made of asbestos, corrugated iron or steel and asbestos, should be able to withstand the increased air pressure due to the heat sufficiently long to enable the audience to escape and the fire department to arrive. Its main object is to localize a stage fire and to cut off the fire, smoke and gases. In order to accomplish this a curtain should close the proscenium opening as nearly as possible hermetically. The specifications before us will not accomplish their purpose.

I note the top of this asbestos curtain only extends about 4 inches above the proscenium arch, while on the sides it only overlaps 8 inches, and even at that this 8 inches is merely wire and lath fresco. The curtain guides are of too light construction and end 6 feet below the gridiron. The asbestos curtain is not properly made, as it fails to state that it is made from a heavy canvas woven from asbestos fibre or reinforced with wire or has wire spun in the asbestos, while the top and bottom bars attached to curtain are of wood. The emergency chains are missing and the operating cable is hung by weights under the stage. I find no quick way to lower the curtain in case of fire. You can see that the most important part of a theatre is almost wholly deficient. Now to correct the same.

The curtain must be made of the best asbestos fibre, tested for strength and be at least 2 feet higher than the proscenium opening and must be at least 18 inches wider on each side of the brick opening. The curtain must be operated in heavy iron "Z Bar" channels on each side of the stage extending clear up to the gridiron and bolted every 2 feet to the proscenium wall. This will make the curtain set in a slot of the channels at least 12 inches. The top and bottom bars should be of wrought iron piping, while iron emergency chains should be attached to the top bar and anchored to the proscenium wall, again to the top bar are attached steel cables, which in turn pass over sheaves, which are fastened to the proscenium wall or gridiron. The cables are to hoist and lower the curtain while the emergency chains are there in case the cables fail, in which case without chains the curtain would drop to the stage floor. The steel curtain cables (to which the curtain is attached by means of metal or hardwood rings at the sides) should be bolted to an iron bracket up at the grid and should pass through the stage floor with a metal bushing and be bolted to an iron bracket to the under part of the proscenium wall. Some arrangement should be devised to instantly lower the curtain in case of fire, and although hardly two theatres have the same arrangement, I believe the old style lash line, which is nothing more than a continuous hemp cord (resembling a clothesline) and entirely encircling the curtain when up, is the best of its kind. If this rope is cut or burned on either side of the stage the curtain will immediately fall. A sharp knife and a sign reading "Cut this rope" appears at each side of the stage.

About two years ago I made a hasty trip over to the Criterion Theatre in Brooklyn and watched a fire which completely destroyed the auditorium section of the theatre. This fire did not cause any damage in the stage building on account of the asbestos curtain successfully cutting off the flames and heat. This was a remarkable demonstration, as the proscenium opening on the stage side clearly showed the smoke flashes which occasionally broke out around the corners of the arch. This is just the reverse of what one would ordinarily expect, in that fires usually start in the stage building.

PROTECTIVE DEVICES

The fire extinguishing appliances according to the specifications are not sufficient, but the fire department or Fire Prevention Bureau will have something to say regarding their installation. Briefly the fire-fighting equipment should include a 4-inch standpipe riser at each side of the stage, at each side of the auditorium, in each tier, in each fly gallery and in the lobby, and each outlet should be provided with 25 feet of 2½-inch labeled unlined hose. Proper siamese and tank supply protected from freezing should complete this equipment. An approved system of wet pipe, automatic sprinklers, preferably with two supplies, should be installed over the stage, in the dressing rooms, work rooms and other sections behind the proscenium wall. An underwriters pump capable of supplying at least 750 gallons of water per minute should be fitted with an automatic regulator, so that when a fire valve is opened the pump will start and keep the tanks or reservoir filled. The auxiliary fire fighting equipment consists of a 40-gallon barrel of water and six fire buckets, an approved fire extinguisher, two axes and two hooks on each fly gallery, on each side of stage, under stage and in property, scenery and other work rooms. An automatic fire alarm and a special building signal with a direct connection to the fire department is a requirement in our city. A watchman's service with an approved clock on which hourly rounds are recorded is perhaps one of the most important safeguards in a theatre building.

INSPECTIONS

The management includes numerous matters of detail and rules and regulations pertaining to the safety of the building on the one hand, and of the audience, the actors and the stage employees on the other. No comment need be made on this subject, except that good management means good housekeeping, satisfied employees and a safe fire risk.

The periodical inspection finally forms a necessary and important safeguard and includes frequent surveys of the building and of its electric, gas, water, steam and fire appliances, all of which should be tested at regular intervals to insure their being in proper working order when needed. In the Paris Opera House, I am informed, there are 25 uniformed firemen always on duty, and this number is doubled whenever a performance is given.

ELIMINATING HAZARDS

I hope I have not bored you with this detail, yet I do not know how this subject could be handled otherwise, and as I look back, many important features, including character of play, roof gardens, spontaneous combustion, etc., have not even been touched upon. A theatre out West has installed light steel frames with thin sheet metal covering, on to which all the scenery is painted, thus doing away with much combustible contents (the idea of fireproofing scenery being really useless), while all the rigging apparatus is steel cables instead of hemp rope. The greatest hazard of previous days; that is, the gas flame, is now practically eliminated. Still electric fires are daily occurring and the stage electrician is responsible for a great many of these fires, as he is ever ready to extend wires or do almost anything with them to meet his purpose. The scene painter and the stage carpenter in a "stock company playhouse" introduces as many hazards as would be found in some omnibus manufacturing risks. Matches, cigars, cigarettes, are used extensively by the actor; lime, calcium and arc lights by the stage-hands; candles by the ladies in the dressing rooms for their makeup; gas stoves by the scene painters for heating water, etc., and lastly gasoline torches by the stage electrician or the engineer. With all these hazardous features constantly at hand in an enclosure filled with flimsy gauze draperies, scenery and properties, is it any wonder that when a stage does take fire the result is so very disastrous?

After all has been said, some of the audience are wondering whether theatres as fire risks can be safely written so as to show a profit on the company's books. My answer to this would be—if of fire resistive construction with a properly constructed proscenium wall, curtain and adequate fire appliances, they are good fire risks, the record proving these to be so, while many of the non-fireproof type with proper proscenium wall, curtain and fire appliances have also given a very good account of themselves. On the contrary, theatres, whether of non-fireproof or fire resistive construction, without a good proscenium wall, curtain and fire appliances are poor fire risks, which fire records have proven them to be.

Some of the data which I have given in this lecture has been taken from Gerhard's book, entitled "Theatre Fires and Panics," and I wish to publicly give credit for same.

INFLAMMABLES AND EXPLOSIVES

Safeguards Against Their Use In Railroad Shops—Report of a Committee of the Railway Fire Protection Association

By C. P. Beistle, W. F. Steffens and G. R. Glenn, Jr.

Dangerous articles used in railroad shops may be grouped under inflammable liquids and compressed gases. No explosives need be considered except such as derive their hazard from are commonly used, but it is possible that vapors from inflammable liquids may be mixed with air in such proportions as to become explosive. No particularly inflammable solid material being saturated with inflammable liquids.

INFLAMMABLE LIQUIDS

The inflammable liquids commonly used in railroad shops are as follows:

Gasoline
Benzine
Distillate
Turpentine and turpentine substitutes
Paint and varnish
Oils, including fuel oils
Alcohol
Wood alcohol
Paint and varnish remover
Lacquers

The term inflammable liquid, as used in this list, does not have the same implication as does this term as used in the Interstate Commerce Commission Regulations, as some of the above articles have a flash point above 80° Fahr.

GASOLINE, BENZINE AND DISTILLATE

Gasoline and benzine are the lighter and more inflammable distillates from crude petroleum. They are of varying specific gravity, but exceedingly inflammable and have a well known characteristic odor. They are used for lighting, heating power and as a solvent. The flash point varies, but is usually 0° Fahr. or below The term distillate is applied to quite similar products in some sections of the country.

These liquids, though used in relatively small portions, are often used, and at numerous points around railroad shops. The *hazard attending* their use is on account of their low flash point, *and consequent* susceptibility to ignition, and their frequent and diversified use. They are essentially materials that greatly increase the fire hazard, as at all ordinary temperatures they give off inflammable vapors, which require only momentary contact with spark or flame to produce fire. While all gasoline is highly inflammable the so-called casinghead gasoline is much more dangerous than the ordinary refinery gasoline. For this reason the use of casinghead gasoline in railroad shops should be entirely prohibited.

Where the main stock of gasoline or benzine exceeds 50 gallons, it should be stored in underground metal tanks, installed in accordance with approved regulations. Where the main supply does not exceed 50 gallons, a steel drum of 50 gallons capacity, with a metal faucet is satisfactory storage container, provided it be kept in a small, well-detached metal enclosure that is kept locked, and is conspicuously marked, "Keep Lights and Fires Away." Where not over 5 gallons constitute the main supply, an approved self-closing safety can may be used. This can should be kept in a cool place. For transferring gasoline from the storage tank or drum to the point at which it is to be used, only approved self-closing safety cans should be used. These safety cans should preferably not exceed one gallon capacity, but should be smaller, if a smaller amount than 1 gallon is sufficient for a day's supply at any point.

The principal uses of gasoline, benzine or distillate in railroad shops are as follows:

Cleaning triple valves or air brake equipment
Cleaning electric generators and motors
Cleaning upholstery
Fuel in blow torches for soldering and paint removing
Fuel for tire removing

In cleaning triple valves there is a variation in practice. Gasoline, kerosene, and lye are used for this purpose in different shops. Gasoline is much more dangerous to handle and use than is kerosene, hence it is recommended that gasoline should not be used.

Where gasoline or kerosene is used for this purpose it should preferably be placed in substantially constructed galvanized iron cans, of as small size as practical for the purpose. The cans should be mounted on the work tables, so that their tops are almost flush with the surface of the table, and should have a drain valve to the lowest point of the bottom. Cans should be provided with hinged covers which will normally be shut, preventing evaporation of the gasoline or kerosene. Gasoline or kerosene remaining in the cleaning cans should be removed through the draining valve at the close of each day. Cleaning work should be conducted at a point remote from open fires, lights or flames, and only approved electric light fixtures should be permitted.

In cleaning electric generator and motor parts with gasoline similar precautions should be taken as in cleaning triple valves. Larger receptacles may be required owing to the larger size of parts to be used, and form of can should preferably be of such proportions as not to be easily upset, as they are usually handled on the floor. They should be provided with hinged self-closing covers, and the liquid contents should be removed from the cans, and stored outside the building at the close of each working day.

Gasoline is sometimes required for removing grease and oil from upholstery and furniture. The gasoline for this purpose should not be kept in or around the shops, in glass bottles, or in open cans or buckets; but in a small standard safety can. When using gasoline for dry cleaning, it is recommended that the material to be cleaned be taken out doors when practicable. It should be kept in mind that in cleaning cloth surfaces with gasoline, the mere friction of the cloth saturated with gasoline upon another surface is sometimes sufficient to produce static electric sparks, which may ignite the vapor. Fires sometimes thus occur in dry cleaning processes, in spite of every precaution in avoiding the proximity of open lights or fires.

Gasoline is used in small blow torches or plumbers' torches for soldering purposes, in electrical repair shops, and for burning off paint. In some shops kerosene is used as fuel in blow torches for the same purpose. The use of kerosene in place of gasoline naturally involves a much less fire hazard and is recommended wherever practicable. Where gasoline torches are used, they should be kept in a fireproof cabinet, preferably located outside, when not in use. They should be filled from a standard safety can, and at a point remote from open lights, flames, or fires, and preferably outside of building. The torches should be frequently inspected to insure that they are in good mechanical condition. Attention is invited to the risk involved in leaving a torch burning without the immediate and constant supervision of the man using it. Fires are frequently caused by workmen going away and leaving a burning gasoline torch. The torch may be upset or moved so that the flame comes in contact with some combustible open material.

It is important that gasoline or kerosene torches for burning off paint, are not used at any place where varnish removing compounds are employed. In some shops large gasoline pressure tanks are used inside main buildings, and the gas produced is used in connection with blow torches for paint removing. Such practice is very hazardous, and should not be permitted. Where gasoline is used in this way these tanks should be in an underground pit, well detached from buildings, and an approved system of piping and connections should be provided.

If tire removing is done with the use of gasoline fuel, the process should be conducted outside of building, and at a safe distance from building. Fuel oil and kerosene are both successfully used for this purpose at some points, are much safer, and are recommended.

At certain locations where it is necessary to use gasoline in considerable quantity, and where local conditions, including municipal regulations, may be rigid, it may be found necessary to install exhaust fan and other special apparatus in order to enable the processes at the particular locations to be continued in service. On one prominent railroad municipal regulations were so rigid that a special building was designed to take care of the cleaning of triple valves with gasoline. Each workbench was constructed of steel frame-work and provided with an inverted hood projecting below the bench and communicating with an exhaust duct extending the length of shop. A grating at the level of the bench prevented parts of valves or tools from falling into the hood, but enabled any liquid gasoline or vapor from it to be promptly withdrawn from the building by operating the exhaust fan located outside of the building and outside of the duct, so that all possibility of sparking was removed. The building was designed of fireproof construction. The additional precaution was taken to have extra vents near the floor at intervals, to insure a rapid withdrawal of any vapor that might find its way to the floor level.

At the time that the plans for this building were prepared there was considerable discussion as to the possibility for the substitution of kerosene or other material for cleaning triple valves. On account of the delicate construction of this mechanism it was decided that gasoline should be continued in service. By constructing an isolated building and providing it with special ventilating facilities described, the hazards due to the use of gasoline could be successfully overcome.

PAINTS AND VARNISHES

Paints and varnishes used in railroad shops are not generally highly inflammable, but are combustible, and are usually kept in quantity. They should be stored if practicable in a separate building of fire resistive construction. If possible, the buildings should be located a sufficient distance from other shop buildings to eliminate the danger of exposure. Paints and varnishes should be stored in sheet iron drums, provided with valves for drawing off the liquid. Metal pans or troughs should be placed under the valves to catch any drip. In case any paint, oil or varnish is spilled it should not be absorbed by sawdust or similar material, but by sand.

Waste, cloth, rags, or other porous or fibrous materials contaminated with paint, varnish, or oil are extremely liable to spontaneous ignition. Fire may result from a very small portion of such material, hence great care must be exercised to keep such material from being left around the premises. Small portions of such materials left in drawers, closets, cupboards, and similar poorly ventilated places are particularly dangerous.

Standard metal waste-cans with self-closing lids should be provided for the reception of waste, cloth or rags contaminated with paint, oil or varnish. This material should be removed from the cans at the close of each working day and burned or otherwise safely disposed of. Overalls, or other garments worn by the painters, or worn in and around paint and oil buildings, are likely to be more or less smeared with paint, varnish or oil, and must not be left near steam pipes or other sources of heat, as in such places they may cause fires.

Ventilated metal lockers should be provided for such garments. The lockers should not be placed in the paint and oil storage building. The building used for paint and varnish storage should preferably be of fire resistive construction. It is recommended that wired glass set in metal frames be used for window openings, and approved fire doors for door openings. At the openings between various sections, small 2-inch concrete sills should be provided. Building should be heated by steam and lighted by electricity, wired in conduit, with vaporproof globes, and switches installed outside of the building.

OIL

Where practicable the oil storage should be a separate building from the paint and varnish storage. When housed in the same building, a distinct subdivision should be provided between the two occupancies by a standard fire wall; any openings therein protected by standard fire doors. Oil houses should be divided into two distinct rooms, the waste room, and the main oil dispensing room. Sometimes a third room is necessary for filled barrels, where no basement is provided. Each compartment should be effectively cut off by the necessary fire walls, with all openings properly protected. The construction, lighting and heating of the oil house should be similar to that recommended for the paint and varnish storage.

The most common form of fire protection for paint, varnish and oil houses is the steam fire extinguishing line, by which steam is introduced into the building. These lines are controlled by manually operated valves located on the outside of the building.

The pipe should terminate in distributors placed uniformly throughout the building, and this pipe should be of adequate size to carry sufficient steam for the size of the building to be protected. The effectiveness of this method of fire extinguishment is dependent upon the complete confinement of the steam, therefore, in order to prevent its escape, all window openings should be equipped with wired glass in metal frames; the windows to be counterbalanced to close with the melting of fusible links. If there are ventilators in the roof, they should also be equipped with self-closing shutters.

The position of the main control valve should be such that it can be readily reached in time of emergency. Attention should be called to the location of this valve by means of a prominent sign, giving not only the information that it is a control valve, but instructions for its use.

An argument has been made against the use of steam-jet, that if the control valve is operated by unauthorized persons while employees are in the room protected by the system, injury by scalding may occur. In order to overcome conditions of this character the control valve can be placed in a special box with glass panel to be broken in order to operate the valve.

For oil fires extinguishers of the foam type may be relied upon, provided that these extinguishers are kept in moderate temperatures during the season of freezing external temperatures. The tenacious blanket of foam delivered by extinguishers of this character completely envelopes a blazing mass and by excluding oxygen extinguishes the fire.

In addition to the above protection a liberal supply of sand in pails should be provided inside the building. On the outside of the building a sign should be posted reading, "Keep Lights and Fires Away."

Empty and filled oil barrels or drums should be stored at as safe a distance as practicable from the oil house, and as an added precaution protected from sparks by a non-combustible shelter. All empty barrels or drums should be tightly closed.

The hazards of, and the recommended practice for handling fuel oil, have been treated in a recent report of another committee of this association.

OIL TEMPERING

At the average railroad shop only small tools and parts are hardened by quenching in oil. But slight hazard exists for this class of risks, owing to the small size of the parts and the small volume of oil in use. The flash point of the oil used for this purpose should not be below 450° F. If at any particular location large parts are hardened by this process the installation must have automatic covers and overflow pipes, and other safeguards as may be necessary.

WASTE

The fire hazards of cotton or woolen wastes used in shops depends on the amount and kind of oil with which they are saturated or contaminated. Saturating a waste with mineral oil, makes the waste more inflammable, but does not render it liable to spontaneous ignition. If the waste is saturated or contaminated with almost any animal or vegetable oil, spontaneous heating or ignition is likely to take place. The greatest liability to heating and ignition is with wastes containing drying or semi-drying oils, such as linseed oil, china wood oil or cotton seed oil.

The wastes commonly used for wiping purposes or for packing journal boxes contain principally mineral oils, and hence are not liable to spontaneous heating. Further the oils in these wastes are of high flash test and hence not likely to give off inflammable vapors at ordinary temperatures. All oily wastes, however, should be stored in tight closed metal containers, regardless of the nature of the oil in them, especially in view of the fact that some doubt may exist as to the nature of the oil.

ALCOHOL

Alcohol and wood alcohol are used in cutting shellac and therefore are commonly used and stored in the paint and oil house and under similar precautions as are used for paints, oils and varnishes. Alcohol is also used for filling hydraulic jacks for out-door service in cold weather, owing to the non-freezing properties of alcohol. When filing these jacks with alcohol care should be taken that there are no lights or fires nearby. Should these jacks leak they should be kept away from lights, and immediately repaired, as the leaking alcohol is likely to cause fire.

Alcohol, oil, or other inflammable liquids should not be used for the hydraulic liquid in large hydraulic installations, consisting of pumps, intensifiers, presses, etc., even where a non-freezing liquid is necessary. Owing to the extremely high pressures required in such installations a very small break or leak may cause a distastrous fire if an inflammable or combustible liquid is used. A water solution of low freezing point should be used.

PAINT AND VARNISH REMOVER

Paint and varnish removing compound is usually a highly inflammable liquid containing acetone, benzol, etc. It is commonly shipped to the shops in wooden barrels, which are stored out-doors until used. These barrels are not always in good condition when received, therefore they should be inspected when received to see that leakage and fire risks do not occur. When paint and varnish remover are being applied to cars, these cars should be outside of, and at a reasonable distance from, any building. During this process no fires, lights, blow torches, etc., should be brought in the vicinity of the car.

In removing paint and varnish from small pieces, it is at times necessary to work indoors. A small detached building should be used for the purpose, if not of fire resistive construction it should have all combustible parts covered with sheet iron. When dipping tanks are used for the varnish remover, they should be provided with tightly fitting self-closing covers, and with overflow pipes leading outside the building. They should be kept covered except when objects are being placed in or removed from the tank. Not more than one barrel of the varnish remover should be kept in the building or compartment in which varnish removing work is done. Care must be taken that any liquid which has spilled or leaked is at once removed. The building should be well ventilated, and if lighted artificially, vapor proof electric lights with wiring in metal conduits must be used.

LACQUERS

Lacquers and enamels for metals consist essentially of nitro-cellulose in amyl-acetate solution, with or without other ingredients. Lacquers and enamels are commonly shipped by the manufacturer to the consumer in boxed cans of not over 5 gallons capacity. They are commonly kept in these shipping containers until used.

Lacquers and enamels are usually applied either by dipping or spraying. When applied by dipping, the dip tank should have approved self-closing covers, and the covers should be kept closed except when articles are being dipped or removed.

Where lacquers or enamels are applied by spraying, the work should be done where there is good ventilation. Ventilators, work tables, or other objects which are in the path of the spray, gradually acquire a coating of non-volatile residues from the lacquers. This residue consists, in large part, of dry nitro-cellulose, mixed with gums, pigments, etc. This mixture is extremely inflammable, and if ignited in any quantity will make a very hot fire, and one difficult to extinguish. These solid residues should not be allowed to accumulate, but should be scraped up, removed, and burned at frequent intervals. Drip boards should be of non-combustible material. The room or building used for lacquering should be lighted by electricity, wired in conduit, with vapor proof lights and switches.

COMPRESSED GASES

The principal compressed gases used in shops are acetylene, oxygen, pintsch gas, and hydrocarbon gas.

Pintsch gas and hydrocarbon gas have less inherent hazard than acetylene and are not liable to explosive decomposition. Cylinders containing pintsch and hydrocarbon must be stored under the same precautions as acetylene cylinders. Care must be taken to prevent them dropping, falling, or being struck by other objects, as shocks thus produced may cause the rupture of the cylinder, or the breaking off of the valve.

It is very important that the cylinders, valves, and all fittings be carefully inspected before use to see that they are in perfect condition and correctly assembled. Numerous fatal accidents have occurred in the use of cylinders of compressed gases for welding, owing to leaky and defective valves, burners, and connections, and on account of connecting the cylinders up in such manner that the high pressure oxygen flows into the cylinders of the inflammable gas.

The handling and use of compressed gases of all kinds should be restricted to carefully selected and trained men.

SULPHURIC ACID

Principal Fire Hazard in Pyrite Burners—Should Be Kept Away From Nitric Acid and Many Other Substances—Processes of Manufacture

By F. J. Haarde, Sunbury, Pa., and A. S. Poffenberger, Harrisburg, Pa., addressing the Pennsylvania Field Club

Common Name—Oil of Vitriol.
Chemical Formula—H_2SO_4.

HISTORY—Sulphuric Acid is perhaps the most important of all chemicals both on account of the large quantities made in all industrial countries and of the many uses to which it is put. It was originally prepared by heating alum, green vitriol and other sulphates and condensing the products of distillation, sulphuric acid, or at least an impure substance containing more or less sulphur trioxide dissolved in water and received considerable attention at the hands of early chemists. The acid so obtained was called "fuming sulphuric acid"; another name being "Nordhausen sulphuric acid," on account of the long continued practice of this process at Nordhausen, Germany.

OCCURRENCE—It is not found to any great extent in the free state, and although enormous quantities of its salts, especially calcium and barium sulphate, are found in many localities, the acid itself is not prepared from these salts; but is more easily obtained by burning sulphur or a sulphide and combining the sulphur dioxide thus formed with more oxygen and water. Ordinary sulphuric acid H_2SO_4, may also be prepared by dissolving sulphur trioxide in water, a reaction combined by great heat. The behavior of water solutions of sulphuric acid is very interesting. The pure acid (100 per cent. H_2SO_4) cannot be prepared by boiling down a weaker acid under any pressure, neither is there much advantage gained by mixing this compound with sulphur trioxide, for when such mixture is concentrated by evaporation, sulphur trioxide is vaporized and the same compound is left. The pure acid, however, may be obtained by strongly cooling the compound when it separates, in the form of white crystals.

PROPERTIES—Sulphuric Acid is a heavy, colorless, odorless, oily liquid, having a specific gravity of 1.8384 at 15 deg. F., being nearly twice as heavy as water. It freezes to a colorless crystaline mass which melts at 10.5 deg. It boils at 338 deg. F., which is a higher temperature than most of the common acids, and many of its uses depend on this fact. At about 400 deg. F. the vapor separates into sulphur trioxide and water; at a red heat further decomposition ensues, the sulphur trioxide separating into dioxide and water. Sulphuric acid mixes with water in all proportions, the heat generated thereby being sufficient to raise the temperature from 0 deg. to 100 deg. C. If such a mixture is made, the acid should be slowly poured into the water (not the water into the acid), with constant stirring. By doing this the heat generated is distributed throughout the large mass of water and the sudden generation of steam, which would cause spattering, is avoided. In addition to the heat development there is also a reduction in volume. Concentrated sulphuric acid absorbs moisture from the air and hence is used considerably as a drying agent, and this tendency of the acid to take up water explains many of its actions. Wood, paper, sugar and similar substances, containing hydrogen and oxygen, are charred by sulphuric acid. On the flesh it acts similarly, a painful wound resulting. With metals, sulphuric acid acts in two ways. At low temperature and when diluted it dissolves iron, nickel and zinc. When concentrated it attacks copper and when also hot it attacks bismuth, mercury and silver, but not aluminum, antimony or lead.

MANUFACTURE—The first step in the manufacture of sulphuric acid is the combustion of sulphur and a large percentage is made from pyrites, which is an ore of more or less pure disulphide of iron and which occurs in large quantities in many countries and which contains from 48 to 50 per cent. of sulphur and is roasted without using any fuel; the oxidation of the sulphur and the iron giving off quite sufficient heat to carry on the process. The ore in the size of a walnut or upwards is roasted in plain kilns or burners provided with a grating of suitable construction for the removal of the cinders, with a side door in the upper part for charging in the fresh ore on the top of the partially burned ore, and with an arch-shaped roof, from which the burner gas is carried away in a flue common to the whole set of kilns. The whole are usually set in rows of twelve or more and are one after another charged once or twice a day at appropriate intervals, so that a regular evolution of gas takes place all the day round. By employing suitable precautions a gas of approximately uniform composition is obtained, containing from six to eight per cent. sulphur dioxide, with a little trioxide and about 12 per cent. oxygen, which is more than sufficient for converting later all the sulphur dioxide into sulphur trioxide, or sulphuirc acid. The burning of "smalls" or "dust" was formerly considered much more difficult and incomplete than that of pieces, but this has been entirely overcome, prinicpally by the "shelf-burner" and mechanical burners, which were almost entirely confined to the United States, where the saving of labor is of primary consideration. The production of sulphuric acid by the assistance of the oxides of the nitrogen is carried out in the "vitriol chambers." These are immense receptacles, mostly from 100 to 200 feet long, 20 to 30 feet wide, and 15 to 25 feet high, constructed of sheet lead, the joists of which being made by fusing them together by a blow pipe without the aid of solder, which would be destroyed by the acid. The vitriol chambers are always erected at a certain height from the ground so that leaks occurring can be easily detected. In nearly all cases these chambers are connected so as to form a set of a cubic capacity of from 100,000 to 200,000 cubic feet, the burner gas being introduced at one end and the waste gas issuing from the other, the movement of the gases being impelled partly by their own chemical reaction and partly by the draught produced by a chimney or tower or by mechanical means. Water is introduced in the shape of the vapors of nitric acid or the lower oxides of nitrogen. By the play of reactions introduced in this way practically the whole of the sulphur dioxide is ultimately converted into sulphuric acid, and at the same time the nitrogen oxides are always recovered with comparatively very slight losses and used over again.

USES—Sulphuric acid is used in the manufacture of artificial fertilizes, chlorine, glucose, nitroglycerine, sodium carbonate, and in oil refineries in the purification of petroleum products it is used to remove, by charring, materials that would give offensive odors in burning. In the preparation of nitroglycerine it aids the reaction by absorbing water. The conductive power of its solutions makes sulphuric acid useful in electric batteries and in plating. It is used also in the production of glucose from starch and water. It is used to dissolve the surface deposit on metals previous to tinning or galvanizing. This process is called "pickling," and is essential if a firmly adherent coating is to be secured. Enormous quantities of sulphuric acid are used in the conversion of certain insoluble phosphate rocks into soluble calcium phosphates, for use as fertilizers. There are few materials in common use by civilized man with which sulphuric acid has not been directly or indirectly connected.

HAZARDS—The hazard involved in the manufacture of sulphuric acid is principally in the pyrite burners, and it is especially important to keep sulphuric acid away from strong nitric acid, bronze and metallic powders, carbides, chlorates, fulminates, picrates, saltpetre and substances impregnated with saltpetre. From an underwriting standpoint, sulphuric acid is not in itself inflammable, nor is it a supporter of combustion. The danger lies in the leakage and possible mixture with other chemicals, principally potassium chlorate, which explodes violently when moistened with the acid. National Fire Protection Association records no great number of fires, nor any serious hazards when the concentrated acid comes in contact with wood or other vegetable matters, a charring action only resulting, and reports only one known fire from this cause.

STORAGE AND SHIPPING—The recommendations for storage of concentrated sulphuric acid is in iron tanks and when shipped should be in iron drums or wood covered glass carboys packed in straw. Diluted sulphuric acid should never be shipped.

HYDROCHLORIC ACID

Does Not Burn and Does Not Support Combustion—Danger Lies in Leakage and Mixture With Other Chemicals

By J. G. Adler, Special Agent, American Alliance, Harrisburg.

Hydrochloric acid is the most useful and chief compound of chlorine. It is a gas, very soluble in water. This solution has always been known as muriatic acid (from the Latin word muria, meaning brine). The term hydrochloric acid means both the gas and its solution, but the solution is usually meant. The early chemists called the gas "spirit of salt." Priestley, who first prepared and studied the gas, called it "marine acid air."

OCCURRENCE.—Chlorides, which are salts of hydrocloric, are abundant in the surface of the earth.

PREPARATION.—The gas is prepared in the laboratory by the method devised by Glauber in the seventeenth century; that is, by heating sulphuric acid and sodium chloride.

Commercial hydrochloric acid is manufactured in enormous quantities by the laboratory method. A mixture of salt and sulphuric acid is moderately heated in a large hemispherical iron pan, and the gas passes through an earthenware pipe into an absorbing tower; the fused mass of acid sodium sulphate and salt is then treated with a higher temperature, and the liberated gas passes through another pipe into the absorbing tower. These towers are filled with coke or pieces of brick over which water is continually running; as the hydrochloric acid gas passes through the tower it is absorbed by the descending water, and flows through the bottom of the tower as concentrated acid. The gas is cooled before it enters the towers. At times the gas passes through earthenware jars before entering the towers, and in these jars the gas and water are caused to flow in opposite directions, thus insuring complete absorption.

Hydrochloric acid gas is a by-product in the manufacture of sodium carbonate by the Leblanc process. The gas was formerly allowed to escape into the air, as it caused the destruction of vegetation and was found to be a nuisance in other ways. A law was passed forbidding the manufacturers to allow it to escape. Therefore, it became necessary to absorb the gas in water. The hydrochloric acid, which was once considered a waste product, is now the chief source of profit, since competition has reduced the price of sodium carbonate.

PROPERTIES.—Hydrochloric acid gas is colorless and transparent. When it escapes into moist air it forms fumes which are minute drops of a solution of the gas in the moisture of the air. It has a choking sharp obnoxious odor. The gas does not burn nor support combustion. It is heavier than air, and may be collected by downward displacement.

The extreme solubility of hydrochloric acid gas in water is one of its principal properties. One liter of water will dissolve about 500 of gas. At the ordinary temperature about 450 liters of gas dissolve in one of water, and as the temperature rises, the solubility decreases. The solution is hydrochloric acid. The gas readily escapes which causes the acid to form fumes when exposed to the air. Pure hydrochloric acid is colorless.

The commercial acid has a yellow color, usually due to iron compounds, but sometimes to organic substances or to dissolved chlorine. Like practically all acids, it acts on litmus paper and surrenders its hydrogen when added to metals.

The strongest acid contains about 42 per cent. (by weight) of the gas, and its specific gravity is 1.2. When the strong acid is heated, the gas is evolved until the solution contains approximately 20 per cent. of the acid, and the liquid boils at 110 degrees C. without further change. The dilute acid loses water until the same conditions prevail.

Large quantities are used in preparing chlorine for the manufacture of bleaching powders, and various chlorides are prepared from it. It is one of the most common acids used in chemical work and laboratories.

In conclusion, although hydrochloric acid is a corrosive liquid, it does not burn and does not support combustion. It is usually shipped and kept in carboys, which should be stored in a cool place, away from the sun and not near other chemicals, waste material or metals as it is capable of bursting carboys if overheated, owing to the pressure of gas generated. The danger lies in leakage and possible mixture with other chemicals likely to cause fire or explosion, otherwise it is a comparatively harmless acid.

PICRIC ACID

A High Explosive Used in Dye-Making—History—Composition—Inherent Properties and Hazards Containers Should Be Marked

Paper Read Before the Pennsylvania Field Club by N. H. Traut, Firemans' Fund, and Murry H. Storms, National Liberty.

Picric acid or acid picronitric, also known as trinitrophenol or trinitrocarbolic acid, is an explosive and dye-stuff formed by the concentrated action of nitric acid on indigo, aniline, resins, silk, wool, leather, etc.

It is the final product of the direct nitration of phenol, and is usually prepared by the nitration of the mixture of phenol sulphonic acids obtained by heating phenol with concentrated sulphuric acid. It may also be obtained by oxidizing the symmetrical trinitrobenzene with potassium ferricyanide in alkaline solution.

It crystallizes from water in yellow plates, melting at 122 degrees centrigrade, which sublime on careful heating, but which explode when heated rapidly. It is poisonous and possesses a bitter taste.

ACID REACTION

It has a strongly acid reaction, being almost comparable with the carboxyllic acids.

By the action of bleaching powder it is converted into chlorpicrin. Phosphorus pentachloride converts it into picyrl chloride, which is a true acid chloride, being decomposed by water with the regeneration of picric acid, and the formation of hydrochloric acid. With ammonia it yields picramide. Silver picrate and methyl iodide yield the methyl ester, which gives, with ammonia, picramide.

Picric acid forms many well defined salts of a yellow or red-brown color. It also yields crystalline compounds with many aromatic hydrocarbons and bases. It imparts a yellow color to silk and wool.

SEVERE HAZARD

The hazard involved in the manufacture of picric acid is severe under some circumstances owing to the use of nitric acid compounds, which in certain stages react and decompose with great violence, large volumes of fumes resulting, which rise and spread rapidly, and which are very inflammable. The substance *particularly* referred to is nitrosso phenol, which is used as an intermediate by manufacturers of dyestuffs, and is produced by treating phenol and sodium nitrate and acid, and unless the phenol is chemically pure, and is guarded against the introduction of foreign substances, it decomposes rapidly, and spontaneously ignites.

At the best it is an unstable product and the lack of knowledge as to how it is likely to act, under various and changing conditions, creates a serious hazard. There is a record of a fire at Hanson, Mass., in March, 1919, in a sprinklered plant occupied for the manufacture of dyestuffs, where an 80 per cent. loss resulted from the spontaneous ignition, of nitrosso phenol, sufficient heat being generated to destroy the sprinkler system while in action, pipes and heads being melted.

DYES AND EXPLOSIVES

Picric acid is used in dyeing establishments and in plants manufacturing high explosives, also to a small extent in the manufacture of medicine.

In dyeing establishments it is used to impart a yellow color to silk and wool, but it is not available for use in dyeing cotton. In fact it is effective only in cases of textiles or articles of animal fiber, and not for those composed of vegetable fiber.

The dyeing solution contains 96 per cent. picric acid and 4 per cent. sulphuric acid. Goods are immersed in this solution while it is cold, but is then brought to the boiling point (122.5 degrees centigrade) gradually, the time taken being from ¾ of an hour to 1 hour. It is kept at this point for from ¼ to ½ hour longer, when the goods are removed, washed and dried.

In the manufacture of explosives, picric acid and/or its salts are combined with gun-cotton to form various modern high explosives, among which are lyddite, the British service explosive; shimose, the Japanese powder, both supposed to be identical with the original melinite; Brugere's powder, a mixture of 54 parts of ammonium picrate and 45 parts of saltpetre; Designolle's powder, composed of potassium picrate, saltpetre and charcoal; and emmonsite, a powder invented by Stephen Emons of this country.

DIFFICULT TO DETONATE

Picric acid itself, when ignited, burns quietly, with considerable smoke, and it is difficult to detonate by percussion, requiring to be enclosed and rapidly heated, or to be started by a powerful detonator. Its salts and compounds with metallic oxides, however, are, when dry, very easily detonated by friction or percussion, and always when heated.

Disregarding the hazards incidental to the manufacture of *picric acid, which are covered* above, the hazard incidental to its use

pends largely upon the methods of handling, and the material
ed in its containers.

NECESSARY PROTECTION

It is important to note, in view of the fact that when comed or in contact with metallic substances, picric acid becomes hly inflammable and explosive, that its containers should iniably be wooden barrels or boxes, absolutely free from any tallic nails or screws, or if, as is sometimes the case, it is t in iron barrels, such barrels should have non-metallic linings. e use of other than all wooden containers should, however, discouraged. The same remarks apply, with equal force, to e tanks used in dyeing establishments, where picric acid is ployed.

It is also important that the acid should be stored in a manmaking it impossible for it to come in contact with other stances, combination with which would be dangerous.

Containers should be prominently labeled with yellow labels, as uired by railroad shipping regulations.

NITRIC ACID

Paper Read Before the Pennsylvania Field Club by Albert C. Gruber, Central National Fire, and John J. Hanlon, American of Newark.

Formula—HNO_3. Latin name, Aqua Fortis (Strong water).

HISTORY

This is, with the exception of ammonia, the earliest compound of nitrogen investigated, its preparation being known to the Egyptians. In the ninth century Gebér obtained it by distilling nitre with blue vitriol and alum, and it was known under various names, such as aqua fortis, spiritus nitri acidus and spiritus nitri fumans Glauberi. Its composition was investigated by Lavoisier (1776) and by Lavoisier and Priestly (1784-1786).

OCCURRENCE

It is found in nature in combination with ammonium, sodium, potassium, calcium, magnesium, and in smaller quantities with aluminum and iron. It is produced by atmospheric electrical discharges, and by oxidation of nitrogenous organic matter through the medium of nitrifying bacteria, subsequently combining with ammonia in the air, and with the various bases present in the soil, and occurs in largest quantity as Chile saltpetre ($NaNO_3$) and Bengal saltpetre (KNO_3).

PREPARATION

There are several methods of preparation, but that most commonly used is to treat saltpetre with oil of vitriol (sulphuric acid) and to distill off the resulting acid, sodium sulphate remaining in the retort. Absolute nitric acid exists only in the form of snow white crystals, but commercially it comes to us in solution of greater or lesser degrees of concentration. In recent years it has been found possible to produce nitric acid by oxidizing the nitrogen in the atmosphere by means of an electric arc and this process is employed to some extent in Norway, Sweden and Switzerland, where very cheap hydroelectric power is obtainable. The gases so produced are cooled rapidly and carried to towers containing milk of lime, the resulting product being extensively used as a fertilizer, but the production of the stronger acid by this means does not seem *commercially possible*, except where water power can be obtained at a cost approximately one-half that prevailing at Niagara Falls. One marked development of the recent war, however, has been the production of nitric acid by the oxidation of ammonia gas (NH_3) passing it, mixed with air, over contact materials and absorbing, oxidizing and concentrating the oxides of nitrogen produced. This development is in too much of a transition stage to be described in detail at the present time.

PROPERTIES

Pure nitric acid is a colorless liquid. It gives off colorless fumes when exposed to the air When boiled it undergoes slight decomposition into oxygen, water, and compounds of nitrogen and oxygen. One of these compounds is colored and this is noticed whenever strong nitric acid is boiled. Nitric acid undergoes a similar decomposition when exposed to the action of the direct rays of the sun. In consequence of this decomposition bottles containing strong nitric acid always contain a reddish-brown gas above the liquid after standing for some time. It acts violently on a great many substances, disintegrating them. It causes bad wounds in contact with the flesh; eats through clothing; burns wood; dissolves metals (excepting gold, platinum and, to a lesser degree, iron); and is altogether one of the most active of chemical substances. In working with the concentrated acid it is necessary to exercise the greatest care.

USES

Used in the manufacture of nitro-cellulose, pyroxylin plastics, synthetic dyestuffs, azo, diazo and amido; in chemical laboratories in analytical and synthetical work; and to some extent in medicine. Its salts are used in electroplating; in the manufacture of explosives, fireworks and colored fires; and as fertilizer.

Pure nitric acid is graded at 99.5 per cent. For ordinary commercial purposes, it comes in three grades, 91.4 per cent. and 56.5 per cent. It costs from four to five and one-half cents for each pound of pure nitric acid in the solution, and sells for five to seven cents per pound. The annual production is about 69.000 tons with a value of about $6.800.000.

STORAGE AND PACKING

Nitric acid is commonly stored in stoneware pots or packed in carboys to be shipped. Care should be exercised that no straw is used in packing as in the event of leakage or breakage the acid, coming into contact with organic matter will cause *fire. Where the* acid is mixed and contains 5 per cent. of *sulphuric acid and not* over three per cent. of water, it can safely be stored in iron tanks. Iron is preferable to lead for strong acid, while stoneware is preferable to either for weaker acid. Probably the safest method of shipping is in rubber encased carboys.

From the above, it is evident that, as a fire prevention measure, the following precautions should be observed in the handling, storage and use of the commodity: Only approved containers, as above described, should be used. Wherever possible the acid should be stored in the open or in small buildings used only for acid storage. Care should be exercised so that in the event of breakage or leakage the acid cannot come in contact with organic matter. It should be so stored that in event of fire the acid will not constitute a menace to firemen or employees fighting the blaze. Bags in which nitre or saltpetre have been contained should be stored in the open or in buildings of low value or of non-combustible construction, completely separated from other buildings.

PROBLEMS MET IN USE AND OCCUPANCY

Losses Not Covered Under Usual Forms of Business Interruption Indemnity; Desirability of Risk; Amount of Liability

By Elliott Middleton, Manager, Pacific Actuarial Bureau

Use and occupancy insurance or business interruption indemnity is of much importance as a source of revenue to the insurance companies, is a needed form of coverage for the public, and is also surrounded at this time with such unusual features, that I have permitted myself to indulge in some observations that embrace not only personal ideas, but also some criticisms that have been made regarding the coverage by thinking underwriters and adjusters. Criticism too frequently is not of the constructive sort. I am led to believe, however, that the men with whom I have talked have not been inclined to cavil or censure, but rather have offered their sincere comments in the hope that use and occupancy insurance may be clarified and ultimately written under rules and forms that will be relieved of ambiguity or where doubt and possible misunderstanding may be minimized. At least, I want to go on record as one who is actuated by this motive.

In regard to the Uniformity Association standard report form which your use and occupancy report form committee has given you at this meeting, I would say that this form is the result of considerable deliberation and your committee believes it merits not only favorable consideration, but adoption and use. It is designed primarily for the use of rating bureaus or rating departments and is intended to permit the inclusion in customary detailed reports of interesting and vital data relating to the use and occupancy of any property and information regarding the situation that would probably confront the underwriter should fire or other disaster cause an interruption of business. While the report form will be of particular value to the rating bureaus, yet it can also be used advantageously by field men or others in assembling data on which to predicate an opinion as to the desirability of a risk from the use and occupancy point of view. If this form will dispel some of the aura of mystery with which some seem to think use and occupancy is surrounded, it will serve a good purpose and its compilers will feel compensated for their efforts.

Questions that not infrequently find lodgment in the underwriting mind in connection with the use and occupancy offering relate to desirability of class of risk covered from the fire insurance point of view, whether or not it is a frame risk or a fireproof, and whether it is likely to burn. The question of desirability of class as stated should not be occasion for alarm unless there is some concern regarding the adequacy or correctness of the fire rate. There have been many cases where, for example, the frame special hazard of large use and occupancy value and rather high fire rate has burned but been replaced quickly with small resulting use and occupancy loss. On the other hand, if a fireproof building sustains a loss causing, say, cracked floor and roof slabs, it may require a considerable length of time to put the building in proper condition for the resumption of operations. In either case, most thoughtful consideration should be given not only to building replacement, but also to the matter of the replacement of machinery or stock. Any fire of appreciable size may cause destruction of machinery and/or stock which could introduce a substantial claim under a use and occupancy policy. Hence, if the fire rate is right and if it is used as a basic thing in building up the use and occupancy rate, if difficulty of replacement of machinery and/or stock is reflected in the U. and O. rate, if there are sufficient risks of the class to give the underwriter some idea as to the probabilities, if the business is one where future prospects are not unfavorable, and, finally, if the assured is an eminently proper person to hold a use and occupancy policy, it would appear that the element of time-to-replace is of more relative importance than the combustibility of the risk. These conditions would seem to emphasize again the value of the standard use and occupancy report form which has been submitted by your use and occupancy committee at this session.

EXTENT OF LIABILITY

Another question to come before the underwriting mind in connection with the acceptance of use and occupancy lines is, how much liability is assumed for loss occasioned by one fire. Admittedly, if all operations are carried on in one building or fire risk, it is, of course, not unreasonable to conclude that any fire that may occur will cause a claim to be made under the U. and O. policy. But, here again the matter of replacement figures most prominently and conditions may permit of an early resumption of operations. The segregation of values and processes while of distinct value under either property damage or use and occupancy policies is not of the same importance with the latter form of indemnity as with the former. The matter of interdependence of sections of a plant has a most important bearing on the U. and O. line and when such a condition exists, it should not be overlooked in the rate, and, further, if a use and occupancy report is writtten for the plant, it should advertise the facts relating to probabilities of loss because of the interruption of business caused by the destruction of any one or more divisions by fire or whatever other contingency is insured against.

While use and occupancy insurance is far from its infancy, and while this form of indemnity would seem to have yielded a fair profit, if unofficial advices are to be credited, yet it still occupies a somewhat unique place in the underwriting world. Many company officials are to be found who are enthusiastic over the coverage as a profitable source of income, there being, however, almost a corresponding number who oppose it. I believe that those who do not look with favor on it incline to their opinion because of certain definite things. Admittedly, the rules of underwriting practice relating to use and occupancy for years were meagre and seriously incomplete and the matter of form was subject to every conceivable abuse. There was no consensus of judgment as to rate and, of course, no schedule, and, lastly, many underwriters felt that such indemnity tended to incite incendiarism. You no doubt have heard and are still hearing comments to the effect that the issuance of a use and occupancy policy weakens the property damage contract. By this is meant that where a property owner holds both a fire insurance policy and a use and occupancy policy, his vigilance is measurably relaxed regarding the danger of fire, and he is indifferent as to whether loss is sustained or not. In short, it is implied that he cannot lose because of his comprehensive coverage. This is a fallacious point of view for several reasons.

In the first place, even with the full coverage as stated, while he will be fully indemnified according to the usual scope of his contracts, yet there are some collateral matters that should not be overlooked. While fire insurance indemnifies for property loss and use and occupancy for loss of net profits and expenses that must necessarily continue in connection with the operations that were interrupted because of fire, yet the owner of a manufacturing plant, for example, usually suffers a financial setback because of trade that not infrequently gets diverted to competitors because of his inability to deliver. He will also suffer because of the unavoidable impairment of his organization, making for lower efficiency involving a curtailment of production as well as the probable making of a temporarily substandard product. With the rehabilitation of the plant, the employment of new labor is usually necessary, which condition slows up production until proper training is given as to the standards of the plant. There is, not infrequently, additional delay in turning *out product* because of lack of experience in the handling of new machinery, and, finally, there may be quite an interval before the old-time esprit de corps is reestablished. All of these conditions and probably others can be translated into dollars in so far as the insured is concerned. Business interruption indemnity does not pay for these kinds of losses and the underwriter's liability ceases when the damaged or destroyed property is replaced and the plant is again put in condition to resume operations.

On the other hand, if only straight fire insurance is carried and the business, whatever it may be, is not a profitable venture, the element of moral hazard creeps in. If the assured yields to the temptation to burn and "sells out to the insurance companies," as the popular expression has it, it might not be considered illogical to hold that the fire underwriter was opposed to fire insurance. The conclusion to be drawn from the foregoing is, of course, that if there is any doubt as to the integrity, honesty or moral fibre of the prospective policyholder, or if his history or any other conditions permit of doubts of any kind being entertained, he is not a proper person to hold either a use and occupancy or a fire policy.

Use and occupancy insurance today is written in accordance with standardized rules and forms and in a majority of the states the application of the use and occupancy schedule or some other well defined rating rules permits of the promulgation of rates that measure the hazard of this form of indemnity.

There is apparently no question but that use and occupancy insurance is here to stay. Manufacturers, merchants, hotel men, owners of theatres, and many others appreciate the plain necessity for it or can be made to see its great advantages if it is explained to them by someone who is thoroughly qualified to do so. If fire insurance is the backbone of credit, use and occupancy may be likened to the muscles and sinews of our commercial life that permit our industries or business to spring up and resume their former activity after sustaining an injury which otherwise might cause a permanent impairment, or at least would serve to retard us in our national development. In the great conservation movement, use and occupancy is doing its part in conserving our industries and in keeping us in the vanguard of world trade. There is a legitimate demand and a vital need for it. It is apparently good business for the companies and much desired by property owners. It is a proper subject for insurance, and I imagine the future years will record an ever-increasing volume of premium from this form of indemnity.

In considering the subject of business interruption indemnity in connection with the present-day industrial uncertainty, a great many angles could be touched on and much more said than the scope of this paper will permit, even assuming that the author were qualified to say it. The present depression and general readjustment of business has introduced some interesting problems. The principal ones perhaps pertain to industrial plants affected by periodical or intermittent shutdown, change in method or product manufactured, and readjustment of prices. The question of shutdown is engaging the particular interest of underwriters at this time, as it touches most closely the fundamentals of the contract. It is also the one on which there is great divergence of opinion. The change in method and product does away entirely with all precedent in the shape of previous records on which settlement could be based. The situation in regard to prices simply adds to the difficulty of settlement on the usual stipulated basis of performance during a preceding period which heretofore has been a condition of the contract.

A review of many use and occupancy lines on plants affected by shutdown would develop the fact that some had been cancelled altogether, others materially reduced, but that quite a number are still in effect, calling for the full per diem over the entire year.

Investigation leads one to believe that a general impression prevails among both assureds and underwriters that if a plant be shut down over a stated period and all of the insurance continued, the assured could in event of loss collect an amount equal to all fixed charges and expenses until the plant is rebuilt or reconditioned for operation. The answer to this falls back to the general precedent established in court, that one cannot collect under a policy of insurance against loss when no loss has been sustained. It is a very evident fact that when a plant is not in operation there is no liability on the part of the insurance companies carrying the use and occupancy cover unless the assured can prove to the satisfaction of the adjuster that definite plans were under way to resume operations on a certain date, but, even then, the liability does not attach until the arrival of the stipulated date when operations are to be resumed. Use and occupancy covers earnings of a manufacturing establishment and before earning any profits the plant must first earn its fixed charges and expenses. Therefore, if it is not in operation, it is earning absolutely nothing. The solution of the general problem of shutdown appears to be the cancellation of all lines on plants that are out of operation indefinitely. In most cases, the assured would willingly acquiesce in this if he were correctly informed as to his status. For plants closed for a specific period, at the end of which operations are to be resumed, and for plants operated intermittently, the principle now applied to seasonal *risks could be used.*

EFFECT OF SHUTDOWN

As an illustration, let us take a well-established concern with a successful history, manufacturing a staple product, that finds itself on a slack market with a surplus of manufactured goods. It is decided to cease operations for three months, say, from June 1, but with full plans to resume on a normal basis at the end of that period. The assured certainly cannot be expected to drop all of their use and occupancy protection. Assuming that they carry a total of $400,000 at $1,333 per day under the full 300-day form; in this case, it would seem reasonable to readjust their insurance as follows: Cancel $100,000 short rate and make form read: "From June 1 to August 31, per day, NIL." "From September 1 to May 31, per day, $1,333." This arrangement would take care of the shutdown contingency and in the event of the destruction of the plant by fire during the period of shutdown, and if the plant could not be restored in time to begin operations as planned, the assured would be protected at least for the nine months. On September 1, the contingency having been disposed of, the $100,000 could be reinstated and the regular twelve-month term provided for. It is not unreasonable to suggest under such conditions as described above that a clause be embodied in the form that would suspend the liability of loss for the period of shutdown with an adjustment of premium on a short rate basis for the amount of insurance so suspended.

ADJUSTING ON MERITS

The two other problems of change in method and product, and change in price level, introduce additional complications to the already precarious adjustment problem. The revised rules of underwriting practice relating to use and occupancy which have recently received the approval of managing underwriters, satisfactorily meet many phases of the subject about which there has heretofore been indecision and doubt. Under the new rules, liability is limited to the actual loss sustained not exceeding 1/300th of the amount of the policy for each business day when operations are totally suspended, due consideration being given to the experience of the business before the fire and the probable experience thereafter. This contractual language should permit of losses being adjusted on their merits. The past performance of the business for any stipulated number of days which has been a prominent part of policy forms prior to this time was only intended to be used as a guide in arriving at the actual producing capacity of the concern insured. The wording, however, was unequivocal in that it was a condition of the insurance that the daily production at the time of the fire should be based upon the average daily production of the plant for the particular number of days of full operation next preceding the fire. The abrogation of the old language is in my judgment a distinct improvement in the coverage and should permit of equitable adjustment being effectuated through harmonious meeting of minds.

In summarizing the various commercial angles, it would appear that merchants have been buying with extreme caution and for immediate needs only, with the result that they are generally understocked. This brings about some necessary curtailment of production on the part of the manufacturer, but plenty of orders are in sight, and with a further stabilizing of prices, normal conditions should automatically recur. The adjustment of the wage scale and other difficulties incidental to production confront the manufacturer, but as a whole the principal businesses of the country are in good shape. From the underwriting viewpoint, therefore, apprehension regarding moral hazard is unwarranted, as it is not so much of a factor as might be imagined. The shutting down of a number of plants does not indicate that there are going to be a great many failures, that manufacturing establishments are going to remain in a state of idleness for a protracted period or that there is going to be a business panic. In fact, with a great many concerns, the effect of a shutdown will be decidedly beneficial and place them on a sounder footing than before. Hence, it may not be undue optimism to maintain that if insurance companies exercise the same good judgment in handling use and occupancy as they do the fire lines that an ever-increasing volume of this class will yield a continuing profit through the succeeding years.

THE HAZARDS OF OIL

Gasoline and Electrical Dangers—Makeshift Buildings—Restrictions on Location—General Hazards Described—Fire Marshals Handicapped

Address by L. T. Hussey, Kansas Fire Marshal, before the Fire Marshals' Association of North America.

I am very much inclined to believe that so far as possible all garages should be of fireproof construction with either cement or dirt floors, which should never be lower than the level of the grade, that all wiring therein should be in conduit, and that every precaution should be taken to safeguard these places where so much value is accumulated and because of their juxtaposition to the business centre of the community.

Doubtless there are those here who have experienced the same conditions that exist in our state. We very often find living apartments, moving picture theatres and other places of public assemblage over garages with very inadequate facilities provided for ingress and egress in case of emergency. I am very much of the opinion that some sort of legislation should be had along this line—that a garage should be of certain construction, that there should be restrictions as to its location in regard to the business district, particularly when of frame construction, and that living quarters, places of public assemblage, etc., over them should be prohibited by statute in all cases where the buildings are not of the fireproof type.

Recently my state experienced two very serious fires in garages, involving a property loss of approximately one-half million dollars. Fire in both instances resulted from causes unknown, and since so many fires are traceable to spontaneous combustion it is only fair to charge these two to that cause. This is one of the outstanding hazards which exist in or about the average garage—the inclination of the owner or employee to throw his dirty waste, his greasy clothing and refuse oil in a barrel or perhaps sweep it out the back door or leave it in some secluded corner where the sun rays or other heat may have a direct bearing on it, and where it is permitted to remain until a fire ensues or an efficient inspector does his duty.

DRY CLEANING

Another outstanding hazard which I am inclined to feel should receive our very careful attention is that of dry cleaning establishments. In many of the smaller towns and some larger ones this work is done in a very crude way without the owners or operators having provided modern machinery or having taken any of the ordinary precautions to safeguard their work, with no apparent realization of the danger they have brought to themselves and those surrounding them. I have gone into some dry cleaning establishments in my state and found tubs of gasoline used for washing clothes, standing in the open. I have gone into garages in my state, as you doubtless have in yours, and found open pans of gasoline used for washing automobile parts sitting around on benches with some of the workmen, and sometimes even the proprietor, smoking cigarettes in close proximity to them, failing to realize that the vapor from one gallon of gasoline is equal to 83½ pounds of 40 per cent dynamite, capable of the total destruction of the average small town if it were exploded under proper conditions.

BAD WIRING

These are some of the outstanding hazards with which we are confronted and which, it would seem to me, are in the province of the members of this association to take cognizance of and stamp out as fast as possible. In some of these places you will find the crudest sort of wiring in existence, done by amateurs without any knowledge of the National Electric Code or very little knowledge of the dangers of electric current. It was recently my duty to go into a large department store in one of the largest cities in my state to make an examination of the wiring. I found one or two instances where the janitor had seen fit to make some connections, one of which was made with a number 10 wire merely hooked over a number 14. The joint was not soldered and was not even taped. You gentlemen who have some knowledge of the situation will appreciate what would have happened in a very short time under these conditions. It was nothing short of criminal carelessness, and it is nothing short of criminal practice, in my judgment, to permit people to do electric wiring indiscriminately, connecting up high voltage and handling electric current as it must necessarily be handled in the varied industries of this country.

We would little think of going to a dentist to have him work upon a tooth or going to a plumber to have a job of plumbing done, or to a physician who had not spent some time studying or did not carry a certificate from some recognized institution indicating that he was competent to perform the service required. Yet people will permit men to come into their places of business, their homes, churches and schools who have no knowledge whatever of the electrical business, excepting what they may have picked up here and there, and allow them to string about their premises wires that carry a current which under certain conditions become great menaces to life and property. I am very strongly of the opinion that one of the things that this association should stand for and use its best efforts to bring about is a uniform system of licensing electricians, so that when this work is done it may be done in a uniform and safe manner.

FARM LIGHTING PLANTS

A new hazard that is confronting most of us along this line is the farm lighting plant. The salesman goes out and sells this plant to the farmer and oftentimes tells him that anyone having a reasonable knowledge of electricity can install this plant. Perhaps the farmer has a son who has been away to college or in high school, and has picked up a smattering of electrical training, perhaps the bare rudiments, who feels competent to do the work. The purchaser of the plant, in order to save a little expense, turns the boy loose without leave or license to install the plant in his dwelling, barn and other buildings, where not only is kept his stock, grain and other valuables, but where the family must live, and it would surprise you to see some of the conditions that we have met up with under these circumstances. The farmer then wonders why in the middle of the night while he is peacefully sleeping a fire breaks out in his home and all of his earthly possessions go up in smoke. These fires are, of course, most disastrous because they usually occur in the dead hour of the night, and farms with even an attempt at protection against fire are as scarce as the proverbial hen's teeth.

A TYPICAL DISASTER

It would seem to me that the fire marshals of this country could render to their various states no greater service than to insist that the most cleanly conditions be maintained in every garage regardless of the size or structure. We should promptly punish any refractions of rules or regulations laid down by our departments for the protection of these places; we should try to educate the public to respect these rules and regulations and make every effort to instill in the minds of the owners, proprietors and employees the necessity of the utmost care being taken in the protection of life and property in and about the premises. We should not neglect to educate the public as to the dangers incident to the use and handling of gasoline and electricity. We should absolutely prohibit smoking in and about any place where gasoline is handled in any manner. Doubtless many of you have read of the Hays City, Kansas, disaster which occurred last year wherein several people were killed and some 28 seriously injured. This accident was due to a leaky carburetor on a truck which was kept in the building adjacent to the distributing tanks of the Standard Oil Co. The distributor drove his truck into this building at night, closing the doors tightly. His carburetor, as well as a leaky valve on one of his service tanks, leaked gasoline into the building continuously during the night. The result was that when he came in the next morning to start his truck the building was thoroughly saturated with gasoline vapor up to and above the level of his carburetor. When he attempted to start his truck the carburetor backfired and an explosion was the result. The flames spread to the adjacent oil tanks and the second explosion followed quickly. One of these tanks was not properly vented, and when it exploded a large portion of it was thrown 400 feet through two dwellings, lodging against the third, leaving a path of death and ruin.

This calls to mind again one of the evils which I think we should carefully look into, and that is the proper installation and venting of all distributing tanks, and no matter how modern or well equipped, they should not be permitted adjacent to the business or residential section of the city or town.

The automobile industry has brought another hazard which it would be well for us to look into—that of the ordinary filling station. Most of these, however, I am very glad to say are metal tanks buried in the ground and filling done in the open. This type is probably as safe as is possible to make them. In some states, I am informed, they are having some trouble with the visible or glass container which is used in pumps at filling stations. I am very glad to say that in Kansas we have not as yet had any serious trouble from this source, but I am inclined to the opinion that we should rule against the use of pressure in these containers, regardless of how little it may be.

I recall an incident, which I think occurred in Texas, where these tanks were under ordinary air pressure of about three pounds. An accident caused by a truck backing against the pump broke the glass, and before the flow could be stopped a lake of 482 gallons of gasoline covered the street adjacent. This became ignited, and the result was not only the demolition of the plant, but the endangering of all property in the neighborhood. Hence, I feel that in my state I shall rule against the pressure pump filling station.

We are told that the automobile industry is yet in its infancy. If that be true, with the increased development of it will came an increased hazard. It would seem that it is our province to study these hazards, and meet them as best we can, and by so doing render to our states a service worthy of the position we occupy.

MARSHALS ARE HANDICAPPED

I fully appreciate that the departments, with possibly a few exceptions, are very much handicapped in the way of funds with which to employ expert men to handle these situations, but I am a firm believer in the theory that we should so far as is possible employ the best talent and give to the solution of these problems our very best efforts.

In closing, let me say that I believe the issues paramount are, first, the enactment of uniform legislation as to the licensing of electricians, insisting in our states that where we have no building codes such legislation be had as will bring about a better quality of garage buildings and prohibit certain classes of buildings being used for that purpose. Finally, do everything in our power to so far as is possible eliminate all hazards whether they are garage, oil or electrical, that in any senes jeopardize life and property.

The fire marshals should be given the right to make certain regulations as to conditions which obtain about these places. We, as protectors of life and property, have a right to expect and demand the co-operation of every community in our work, and we should feel no hesitancy in asserting our demands.

DANGEROUS ELECTRICAL CONDITIONS

Frequent Inspections Necessary, Heavy Losses Continuing—Co-operation Between Companies and Contractors—Organized Reinspections Urged

By W. J. Tallamy, Insurance Engineer, New York

The vast amount of time, effort and money being devoted throughout the United States each year, in the interest of fire prevention along educational lines does not appear to be bringing about anything like appropriate returns as is shown by the fact that our national fire waste is constantly increasing. During the first six months of this year the fire loss in the United States amounted to over $132,000,000, an increase of nearly $27,000,000, or about 25 per cent. greater than that for the same period last year.

This would indicate that those responsible for avoidable fires are either not being reached through educational channels or that they are grossly indifferent as to their personal responsibilities in the matter of fire waste.

It is obvious, therefore, that more drastic measures must sooner or later be taken if our national fire loss is to be kept within reasonable bounds.

CORRECT LEGISLATION

The adoption of corrective legislation, such as would penalize fires resulting from wanton carelessness and indifference to common well known hazards, would undoubtedly bring prompt relief, but until this can be accomplished, we must use to the utmost the available means of fire hazard elimination now at our disposal.

Take for example the fire loss resulting directly from electrical defects. It is roughly estimated that at least 10 per cent. of our national fire loss each year is caused by fires of electrical origin resulting from unapproved conditions.

The full meaning of this will be better appreciated when we pause to realize that electrical hazards, such as are causing an annual national fire waste of nearly $30,000,000, are almost entirely under the possible control of fire insurance organizations.

•The public in general knows very little about electrical fire hazards. It depends largely upon the judgment of fire insurance inspection and rating organizations for the safety of electrical equipment as is indicated by the fact that a large proportion of the contracts for the installation of elec-

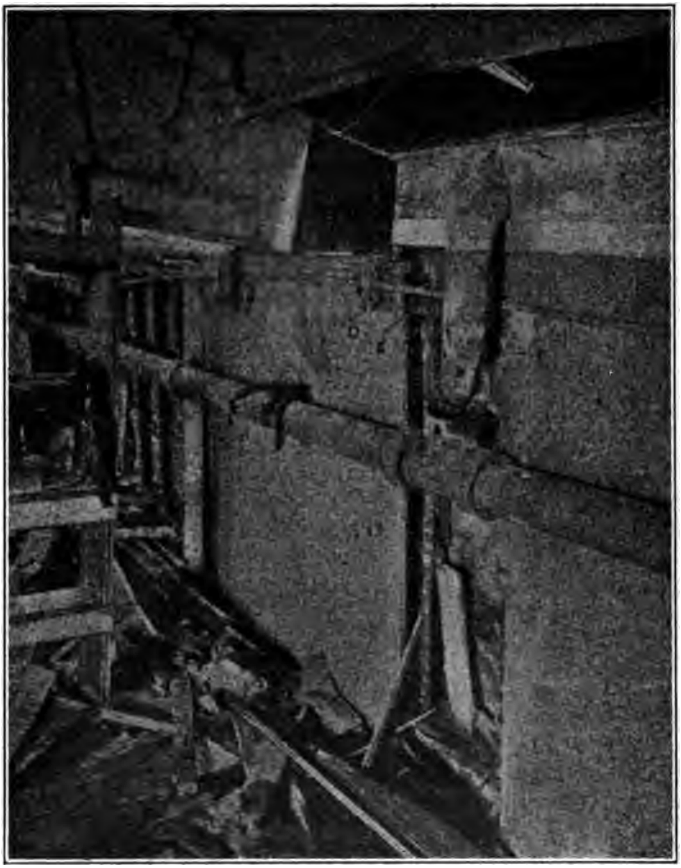


Photo N. F. P. A. Quarterly

FIRE CAUSED BY CONTACT OF TROLLEY FEEDER WITH FIRE ESCAPE. *NUT AND PLATE* AT END OF FUSED ROD D SUPPORTING *FIRE ESCAPE,* UNUSED GAS PIPE E; ROOF DRAIN F trical equipments are made subject to the approval of the Underwriters Association having jurisdiction.

EVIDENCE DESTROYED

According to the New York Fire Department Report, the fire loss caused by the electrical defects in Greater New York alone, during the year 1916 amounted to $997,980. Undoubtedly the actual fire loss due to electrical causes exceeded this amount, as a large proportion of fires, particularly night fires, totally destroyed the evidence of their cause.

Records of the New York Board of Fire Underwriters, covering a period of several years show over 75 per cent. of the fires unmistakably of electrical origin, were directly due to unapproved conditions; many of the defects having crept into the risks after the original underwriters' certificate of approval had been issued, while some equipments had never been inspected, although the risks themselves had been covered by fire insurance with permits granting the use of electricity incorporatd in the policy forms.

In a general way similar conditions seem to apply throughout the country, although in smaller municipalities greater difficulty may be experienced in securing the use of electric current when supplied by a public service station, until at least the first certificate of approval is issued by the local underwriters electrical inspection department.

WORK RESTRICTED

In any case, it is obvious that the work of electrical inspection departments is too restricted, that there is a lack of complete co-operation between electric lighting and power supply stations, electric inspection and fire insurance underwriting and rating organizations and that the conditions contained in the policy form are not being properly complied with.

A fire occurred in one of our large cities a few months ago which furnished an interesting example of how much existing conditions can be used to the disadvantage of and unjust expense to fire insurance companies by unscrupulous people. The building was an ordinary two-story frame structure with mercantile occupancies on the second floor. The electrical equipment on this floor was installed about October 1st, 1917, but had never been inspected by the Electrical Inspection Department, presumably because the owner and the electrical contractor who did the work, wishing to avoid paying fee for the inspection, made no report concerning same. The electrical equipment on the first floor was installed several years previous and had been inspected

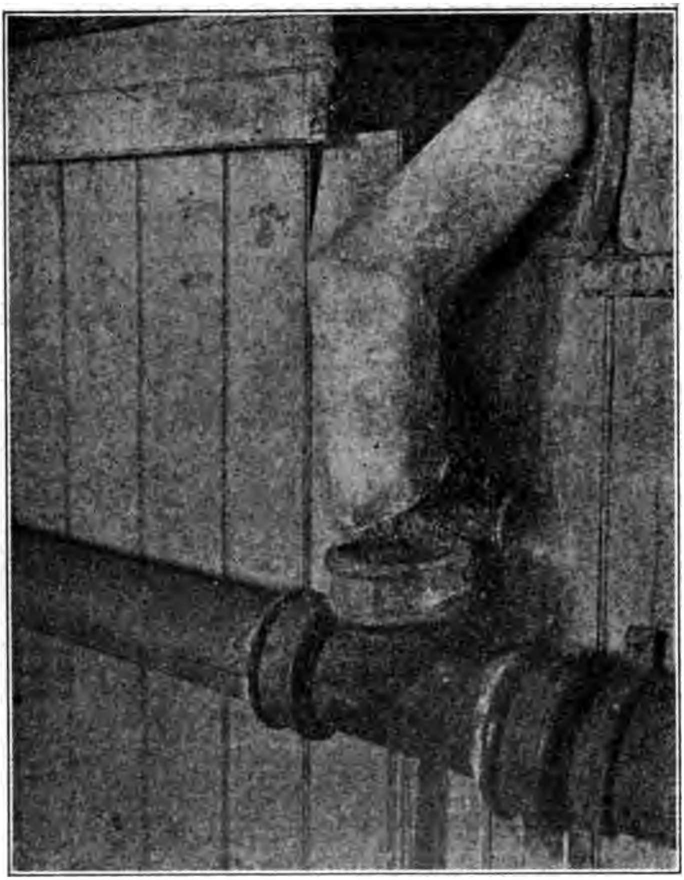


Photo N. F. P. A. Quarterly

SEWER PIPES DAMAGED OR FUSED BY HEAT GENERATED BY RESISTANCE TO THE CURRENT IN GROUNDING. NOTE THE CHARRED SHEATHING no less than eight times, two of these inspections being made after the second floor equipment had been installed. The risk was specifically rated about 18 months after the second floor equipment had been installed, apparently no notice having been taken of the presence of the defective conditions, or the fact that no certificate of approval had been secured from the Electrical Inspection Department, as required by a rider attached to the policy form. This is only one of the many examples of fires of electrical origin that are constantly occurring, the means of preventing at least a large part of which lies well within reach of the fire insurance underwriters, who are called upon to pay the losses involved.

Electric lighting and power stations are obviously anxious to avoid dangerous electrical conditions in plants which they supply, because of the possibility of subrogation claims and the business loss usually incurred by fires likely to result therefrom. Courts have ruled that they are justified in requiring a certificate of approval of all electrical wiring by the Underwriters Electrical Inspection Department before turning on the electric current.

ONLY NEW YORK INSPECTED

Electrical inspections at the present time are almost entirely confined to new work and are made at the request of electrical contractors, who are usually required to furnish an Underwriters certificate of approval before they can secure final payment under contract.

There is a lamentable absence of systematic periodic reinspection work in connection with electrical equipments, hence, after the first certificate of approval is secured all sorts of unapprovable changes can be and frequently are made to the equipments without regard to the hazard involved.

An analysis of electrical fire causes throughout the country indicates that a large proportion of the fires of electrical origin are directly due to unapproved changes in previously approved equipments, said changes having been made without the knowledge or consent of the electrical inspection department having jurisdiction.

These changes are frequently made by boys, students, janitors, porters, mechanics and engineers, who have had little or no training or experience in electrical matters, know nothing of electrical fire hazards and are therefore totally unqualified for such work.

DEFECTS UNNOTICED

In the absence of an organized system of electrical reinspection work, dangerous electrical conditions brought about

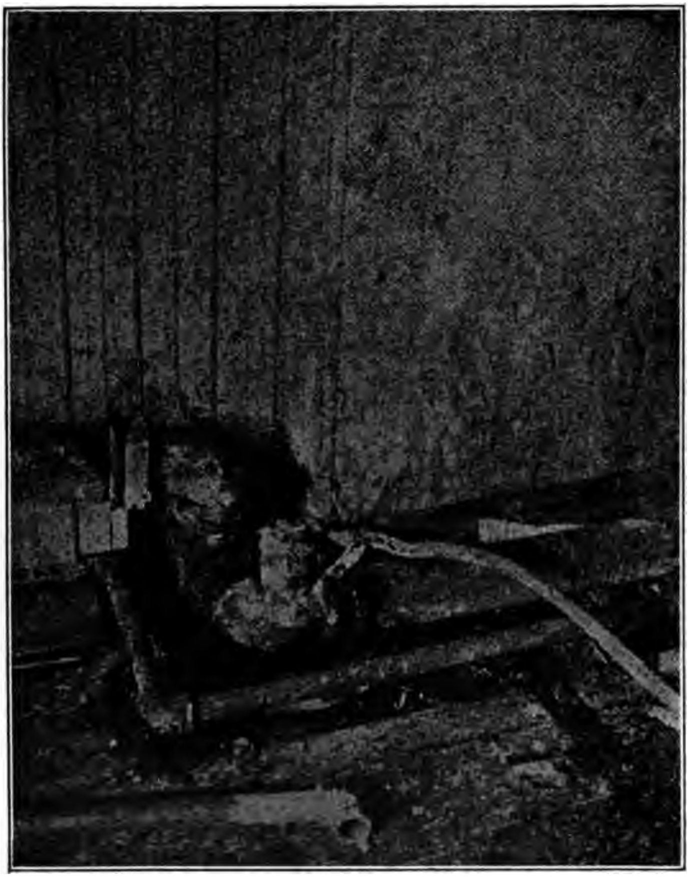


Photo N. F. P. A. Quarterly

ELECTRIC CURRENT IN GROUNDING JUMPED FROM SEWER PIPES TO WATER PIPES, FUSING BOTH in this manner, are allowed to exist unnoticed until they make their presence known by causing a fire, which almost invariably results in loss to fire insurance companies, for it is seldom possible to fix the responsibility with the assured in such cases.

As a rule, inspectors for rating organizations, are not electrical experts and therefore pay little or no attention to electrical equipments in fixing fire insurance rates. A risk, therefore, might have a seriously defective electrical equipment and be rated without the application of a proper charge for defects. It is obviously unfair to rate a risk unless all of the hazards have been taken into consideration and in the absence of reinspection of the electrical equipment by an electrical expert, dangerous electrical hazards are likely to creep in and be overlooked.

Photo N. F. P. A. Quarterly

IMPROPER IRON ARRANGEMENT; A NON-REINFORCED CORD; B METAL SOCKET; C WHERE THE STAND SHOULD BE; D GROUNDED TUBS; E, F BURNING IRON

When the presence of electrical defects in ordinary risks is brought to the attention of the fire insurance rating departments, a flat charge is frequently made, irrespective of the nature of the defect. In many instances such a charge is likely to be totally inadequate.

For example, a risk might easily be so seriously defective that an entirely new equipment would be required to bring it up to the present standard. The probable cost of the required changes might be so much in excess of what the flat charge would be, that the assured might find it more economical to pay the rate charge than to make his property safe from electrical fire hazards. Under conditions such as these a flat or average charge, seldom over twenty-five cents would hardly provide an adequate rate.

According to statistics compiled by the National Board of Fire Underwriters, the defective electric pressing iron and the loose flexible electric cord cause more fires than any other electrical defects. The chief hazard in connection with the pressing iron is due to the careless manner in which it is handled. Inflammable pressing bench coverings and improper stands are the necessary contributing causes to fires of this origin.

ELECTRIC IRON HAZARD

Notwithstanding the present tremendous cost of pressing bench fires, due to electric irons alone and gas heated pressing irons are even more hazardous for the same reasons, some of our fire insurance rating exchanges permit pressing benches in factories, if first covered with metal, to be recovered with fabric and other inflammable padding of unlimited thickness, with no additional protection between the pressing iron and the inflammable bench covering, except the open iron stand, the legs of which sometimes become embedded in the fabric covering, causing it to raise to a point dangerously close to the hot iron. Even if this hazard were not producing any great number of fires in factories, it is bad practice to encourage the use of inflammable material directly below the pressing iron. Those who know of the approval of this common practice in factories can hardly be expected to provide better conditions in the home or elsewhere, when under their control.

The chief danger in connection with flexible electric cords and loose wires is the possibility of their contact with exposed or open grounds, such as piping, metal, damp wood, nails, books, other wires, etc., which is likely to cause short *circuit, and produce* an arc sufficient to ignite an insulation *and start a fire.*

That the combined action of age and weather conditions often has a very important influence upon the life and safety of electrical equipments, particularly when exposed, is frequently indicated by disastrous fires.

Such a fire occurred in an ordinary five-story brick and stone mercantile building, about three years ago. An iron fire escape on the street side of the building, anchored to the stone wall throughout, except at the 5th floor where its iron supporting member passed through the wood cornice and was held in place by an iron plate and nut at the inner surface of the wall. A 550-volt trolley feeder wire passed the building, close to the fire escape; a wood collar being provided for the wire to prevent its contact with the fire escape. Constant exposure to weather conditions and vibration caused the wood thimble to lose its insulating value, permitting the current to ground through the fire escape. Strangely enough, although the point of contact between the wire and the fire escape was at the second floor, the current passed upward through the iron work of the fire escape to the point where the latter entered the building at its fifth floor anchorage where the current shunted to an unused pipe through which it passed shunting to water and soil pipes, in various parts of the building in grounding; forming arcs, fusing the pipes and causing considerable water damage before the water control valves could be located and closed. As leaded pipe joints melted away, due to the heat of resistance, additional arcs were formed resulting in the simultaneous breaking out of several fires in various parts of the building where woodwork and other inflammable material was exposed.

Fortunately these fires were discovered promptly. Extinguishment, however, was difficult, owing to the unusual origin and nature of the fire. A close examination revealed a number of instances where iron bars and piping were completely melted away by the heat from the electric arcs, formed by the current in grounding.

RECOMMENDATIONS

In view of existing conditions and with the hope of bringing about some improvement along these lines, the following recommendations are made:

(1) Every effort should be made to bring about a closer form of co-operation and more friendly business relations between the electric light and power supply companies and the electrical underwriters inspection departments, with the *view of having all* new and changed electrical equipment

comply with the present code of standards, without exception, before the current is turned on.

(2) All electrical contracts should have incorporated in their form a requirement for special permits before *any* change is made in the equipment and any infraction of this rule should be properly penalized.

(3) That electrical inspection work be more general and not entirely dependent upon the requests by electrical contractors, and that a system of periodic electrical reinspection work be adopted by the various electric inspection departments throughout the country, with the view of detecting unauthorized changes in previously approved equipments, correcting unsafe conditions that may have developed through constant service and gradually bringing all old and obsolete equipments up to the present standards of safety.

(4) Much benefit would be likely to follow if the rating exchange were to make it a point to confer with the electrical inspection departments in connection with the equipped risks in all instances before applying the final rate. If no inspection has been made, one should be insisted upon, in order to provide a proper and adequate charge for unapproved electrical equipment. Electric defects should be classified according to their seriousness and charges fixed accordingly.

In view of the millions of dollars in fire loss annually directly due to detectable electrical defects, it would be an excellent investment to materially broaden electrical inspection work, at the same time striving for the closest application of friendly co-operation between all of the available fire reducing agencies. In all probability there are comparatively few electrically equipped buildings entirely free from electrical defects at the present time.

SYSTEMATIC SURVEYS OF FIRE RISKS

Accuracy in Rating Risks—What to Look For—Methodical Inspections—Intensive Notes—Practical Experience

By W. W. Mouch, formerly Inspector, Ohio Bureau

Accuracy cannot be urged upon too much in the estimating of fire rates, when the time and money involved is considered, not to speak of the insurance cost of the assured, which swings so directly in the control of the inspector delegated to that particular risk.

Naturally, every inspector has his own peculiar way of going about the work, some of which may be efficient, while others may be the cause of errors of various kinds which regularly creep into his work. Doubtless there are few rating men who have not experienced many times the desire for another look at some certain feature of a building on which they failed on the initial trip. Often such a view is impossible, because the risk is located many miles away. My experience has led me to believe that a lack of information is usually due to a want of system in making the survey. This fault is further developed by hurry on the part of the inspector to catch a train or to escape weather conditions.

These few lines may not impart anything that is new to the experienced handler of the fire schedule, but it may be of some help to the beginner, who is the one that really needs instruction. As a rule the new man is given a schedule, and after a few preliminary trips with an older man, he is turned loose, so to speak, on small work and told to dig for himself. Gradually he works into the more difficult classes of risks. Such is all well as far as it goes, but the point is, and there lies the trouble, it does not go far enough. Rarely does he receive any instruction in "how to make an inspection" with the result that he forms many incorrect habits, makes mistakes and wastes time and a great many other wrinkles that have to be ironed out later.

CORRECTNESS OF RATE

In fairness to all concerned it is only right to say that a rate should be established exactly on the conditions that exist at the time the rate is made. The companies should receive a premium which is in proportion to and based on the fire hazards that are present while the assured should pay for that amount and no more. Further, the correctness of a rate becomes more important, if in the future the assured makes a number of improvements for which he expects a corresponding decrease. However, if under the old rate a number of charges has been left out and then are made under a re-rating with the result that the new rate is no lower or possibly higher, then the assured is perplexed, sometimes disgusted and wonders just what kind of method is used in arriving at a fire rate.

Explanation rarely serves to straighten out such tangles, for the knowledge of the average property owner about fire insurance estimates is limited at the best, and the schedule man cannot possibly explain to him in a few minutes or hours what it has taken him several years to learn. So that it behooves the bureau man or the insurance engineer to know his business and to be extremely accurate in all of his surveys, if he is to maintain the respect and consistency of his chosen profession in the eyes of the insuring public; who are always quick and apt in the picking of possible flaws.

Inexperienced inspectors usually have so many things which they are endeavoring to remember, coupled with the anxiety to find all the details about the risk which they are inspecting at the time, that confusion often results and some features are missed, and when they return to the office to make up the rate they are uncertain about some of the charges to be made. Where systematic inspection is carried out, much of this uncertainty is eliminated. In addition the student will become acquainted with the schedule and its application more quickly than otherwise.

Strictly speaking, an examination of a fire risk starts in the office, where the existing rate sheet is gone over in a general way and at the same time it should be noted from the re-rating request what the reasons are for asking for the promulgation of a new rate. Following this the risk should be located on the map from which a sketch of the building should be traced. The diagram is especially important if the structure is located in another town or city. With this preliminary information, the rating man is better equipped to note any changes in the risk upon his arrival or to catch any details that may have been passed over formerly. In short, he is prepared to make an intelligent inspection.

OUTSIDE INSPECTION

After arriving at the designated property, it is well to first look the building over from the outside on all sides, where possible, noting the construction of the walls, height of parapets, roof houses or other attachments, openings in the walls as well as those of exposing risks, if any, and their position. In the routine of these features it then can be noted whether any structural changes have been made in the structure. In the meantime the inspector should be taking down legible notes, which are complete enough that no doubt will arise as to the exact information they are to convey to the inspector later. Notes on fire hazards that are only half taken are worse than none, for they only reveal a mass of uncertainties that is akin to chaos. One should never fall into the lazy method of taking notes that I have known some inspectors to use, and which is that of merely checking off the items on the old survey as they are found and trusting to memory for the remainder. When the risk is only a small ordinary mercantile building, extreme care in keeping one's notes separated is not necessary. However, if the risk is of any size or involves a number of various features or buildings, then they should be taken down uniformly with reference to each floor in each building. This is especially true in the case of the manufacturing plant with several buildings, located in another town, which prohibits a second inspection.

Following the obtaining of the data on the outside, the next in line is to enter the building and get in touch with the owner or occupant, as the case may be. From the standpoint of diplomacy, ethics of the business or what else, the inspector should never look about the building without first explaining the reason for his visit, because he has no vested authority, and is only getting information for a private enterprise. Some inspectors take advantage of their position and in so doing only injure the interests of the agent, company and Bureau. Further, the antagonism of the assured is often incurred, if his permission is not first gained, which in turn causes the Bureau man a lot of extra trouble and effort. The owner's good will should always be sought, for he can often give valuable information that the inspector might not obtain otherwise. In the case of the special hazard risk, this is more important than at any other time, as it enables the rating man to save time, obtains explanations on certain features which might be somewhat vague and, in general, he gets a more true perspective, a bird's-eye view, so to speak, of the plant. On the other hand, the assured is more apt to feel that he has been rendered a real service, all of which tends to uphold the respect of the insurance field in the eyes of the public, who is paying the bill after all. The Bureau is an organization maintained to estimate fire rates, and in reality a representative of the various companies, who, in supporting such an organization, is performing a big service for the insuring public; so that it behooves the schedule man to help make that service all that it should be, which calls to my mind the matter of making suggestions for improvements to the assured while making the inspection. A great many inspectors will often evade the property owner by some round-about answer when he asks what can be done to get a better rate and improve the condition of the risk. But I have always held that he should not do this. It is his duty to aid the assured whenever it is at all feasible to do so. In addition it only serves to broaden himself, as it calls upon him to exercise his judgment on various fire hazards.

THE GRATING HAZARD

In going up I believe that one can ascertain better the things that go to make up a fire rate than any other way. With this view in mind, it is advisable to start the inspection in the basement. The first matter to be noted is that of structural details, such as floorway openings, floorway construction, etc. Next in order are the occupancy features, as heat, light, power, furnaces, ovens and any kind of machinery that involves any fire hazards, and finally the stocks should all be inspected one at a time. Information as set forth on the old survey should never be taken for granted, for the best of schedule men will make mistakes and changes in the risk are too likely. So that one can never be safe in assuming that conditions are unchanged. "Care and maintenance" is always an important matter in the basement. Rubbishy conditions in the cellar are the cause of a great many fire losses. Yet, many people are prone to disregard this fire hazard and seem to think that anything dumped in the basement is safe. The rubbishy basement is sometimes made still worse from a fire standpoint by the presence of open grates in the sidewalk, which serve as entrances from the outside, or as a source to gain natural light, because of the ever-present cigarette or cigar butt, which can fall through so easily.

In this way the entire building is gone over from floor to floor until the top floor is reached. Then, if it is possible, the inspector should get out on the roof. This position gives one a different view of the structure and its exposing neighbors than can be gained elsewhere. Further, it leaves no doubt as to heights of parapet-roof houses, skylights and the location of windows in the walls of exposing buildings. At this point the survey is practically complete, there being nothing left to be done but to check over all details, which the return trip down affords very well. Before, it is well to look over one's notes to make sure that no item has been omitted. If any matter has been forgotten a scan of the items on the survey itself will often call to mind something that has been left out. In going down there is only *one thing* for the inspector to do, and that is to look for errors, *which he usually will find* if he is close enough observer.

Determining various structural features is often difficult, such as floorway and wall thicknesses, because there are no accessible places to take a measurement. Under such conditions it is compulsory to rely on the map or information furnished by the assured. Outside walls should always be thoroughly sounded to see that they are not furred walls or brick-veneered, or that there are no openings into other buildings that have been boarded over and then covered with paper. At a distance such an opening will appear to be of solid brick and frequently go unnoticed for several years. But under closer observation they can usually be detected by the fine lines around the edge that the paper forms. Another item that is not rare at all is that of roof joists which extend through fire walls from one risk to another. Such structural hazards are not to be disregarded, and only the most careful inspection work will ferret them out. The same is also true of the wood window sill which is left in the wall after a window opening has been filled in with brick, as stock is sometimes piled against that particular part of the wall. If it is in the open, it will often go unseen, because of its very apparentness. In fact, any irregularity in construction which would contribute to a greater loss in the event of fire should be carefully noted by the surveyor. Walls are found in a buckled state occasionally and, as a rule, is the result of a former fire, age of the risk, excessive loads on floors or a settling of the ground underneath the building. These matters will exert a contributing force in a fire and are chargeable according to their location, kind of risk and degree of imperfection.

PROTECTIVE MAINTENANCE

Generally speaking, the average assured after installing fire-protective features never gives them any further attention until someone calls to his mind that they have been neglected. Such is frequently the case of fire doors. Where they are found by the inspector, they should be tested to insure that they would close if the occasion arose demanding their release. In some classes of risks fire retardants deteriorate very quickly either through the rough treatment that they are subjected or such destroying agencies, as vapors, gases, acids and the weather in certain cases. Obviously, a fire door which will not operate is worse than none, and its very purpose is defeated. Other forms of protection are neglected in the same way. Such should not be the case, for fire is a peculiar thing, which has the habit of breaking out at the most inopportune time. Chemical extinguishers of the "soda and acid" type should be recharged once each year, in order that they may be known to be in working order. A charge will retain its strength for a longer period than a year, but it is never certain. Another *fault* that is true of chemicals a great many times *is that of location.* They are, at times, hung every place but the right place, such as dark corners, stairways or are covered over with stock in such a way that they would not be available for use if needed. Things of this nature usually seem trifling to the assured, but they are not to be overlooked by the good inspector and who should attempt to get a correction of them at the time.

Standpipe and hose systems are seldom needed and often lay in the racks for several years without ever being touched. Then, when the time comes that they are needed quickly, they are found to be out of repair. Such a predicament, of course, is worse than no protection at all, for the assured has relied upon something that did not exist. Naturally, such a catastrophe can only be averted by giving the entire hose system occasional inspections and knowing that all valves and connections are oiled, so that they will operate freely. Floor space about the hose racks should be kept free of all obstacles in order to permit access and instant use. The matter of water pressure should be looked up by the inspector, for it sometimes happens that the pressure is not what is required to give an adequate stream, especially on the upper floors. Watchman's service is another protective item that is subject to change. A risk will be given credit for watchman service, then in the course of a year or so it may be maintained only partly or discontinued altogether without any knowledge on the part of the company or Bureau. So that it is up to the next visiting inspector to catch a change of this nature or any other kind. In the same way all other forms of protection should be closely scrutinized, such as blower and ventilating systems, motor enclosures, packing bins, fire alarm and escapes.

As noted elsewhere, the taking of intensive notes is highly important, which goes hand in hand with the judgment that the inspector is able to exercise, for upon his judgment depends the quality of his notes. Of course, the ability to size up and measure fire hazards is only acquired through practical experience. As one philosopher has so aptly said, "Experience is knowledge, and knowledge is judgment." As regards fire hazards this is certainly very true, to say the least. Like any other book on any particular subject, "The Analytical Schedule For the Measurement of Relative Fire Hazards" does not and never can cover every detail of its field. So that at times, when these lapses are encountered, some points involved are left to the discretion of the inspector. To decide upon these peculiar cases, he must rely upon his judgment by bringing before him all possible facts that have a direct or indirect bearing on the matter at hand. Naturally on his past experiences depends the reserve stock of fundamentals that he will have at his command. Thus, he is able to draw conclusions that will carry weight. From this angle of thought it is not difficult to reason that it behooves the schedule man to study carefully all unusual hazards when he is making a survey, if his deductions that are made later in the office are to be just and accurate, and if he is to broaden out in the measuring of fire hazards in general. One of the pitfalls that the regular schedule user must sidestep is that of becoming too technical in his views. This fault is not so apparent at first, but makes its appearance after the inspector becomes more thoroughly experienced, when he either continues to grow more broad-minded or else becomes so filled with technique from constant handling of the schedule that he only sees the matter in question as the schedule seemingly treats it.

Obviously, it is the solving of these questions and knowing where and when to deviate from the rules of the schedule and when to adhere strictly to them, that the real science of applying the fire schedule makes its appearance, and then only in the hands of a broad-minded actuaralist who can see and appreciate the problems from all angles. Though, in general, fire risks of the same kind are alike, yet they often differ from one another in certain details, which, if noted carefully, may effect the resultant rates. Ability to mark these small but important differentials, as a rule, is the demarcation between an authority on fire hazards and the average or mediocre inspector.

"AFTER CHARGES"

In the matter of setting after charges in the rate for such features as wiring defects, age and condition, care and maintenance, smoking signs, lack of metal waste cans, unsafe arrangements of power and heating devises and any other undesirable feature not covered by the schedule directly, the usual tendency is to put on arbitrarily a certain amount for each one. These charges are applied in the nature of a penalty with the idea of causing the assured to remedy the defect in a short time. But, frequently, they are never given any attention by the owner and may exist for several years. In making these charge the inspector should study closely each defect to determine just what degree of hazard that it adds to the risk, according to the kind of risk, as the same condition may be more hazardous in one building that it would be in another. Also, the matter of time is to be considered. On the day that the inspector visits a risk it may be in a very bad condition as regards cleanliness, but on the average it may be kept very good. Such a matter as this depends partly upon the moral hazard that exists in any particular risk, and a fair estimate can only be arrived at by the surveyor, who can read and know human nature. The thought that is to be construed from this, of course, is that the inspector should not be too quick to form his opinions on just what he sees *at any particular* time, but, rather, that his conclusions should be based on past and future as well. A viewpoint of this kind can usually be obtained by conversation with the assured and employees.

Regardless of the kind of structure or number of buildings the foregoing system can be used without making any perceptible changes. However, in the fire-resistive type of risk, it usually behooves the inspector to be more thorough than ever in his work, for the reason that one can easily be misled as to the true construction. A building may appear to be of fire-resistive construction in all respects and yet not be when examined more closely. There is one type of building, which is known as Berger construction, which seems at first to meet all the requirements outwardly, but in reality does not. This type of structure is much the same as a standard fire-resistive risk, so far as the walls, stairways and the like are concerned, but differs in the floorways and roof. Steel I-beams are strung, over which is laid a heavy wire netting. On this is poured the concrete, with which hollow tile is sometimes used. From the top side this kind of construction appears the same as reinforced concrete. However, on the under side, unless the ceiling is ceiled-up with something, the steel supports are left exposed and under intense heat would soon buckle and probably result in as great a loss as in the ordinary brick construction. When the inspector cannot find out all that he wishes to know about a risk, then he should consult the contractor or owner, as they usually can answer any questions in regard to construction. Occasionally the plans are available, and these, naturally, furnish the best source of information.

In the case of a new risk that has never been rated before, it is advisable to deviate some from the plan that has been outlined in the foregoing. A map of the risk should be made first, showing its size, location and construction. Then a thorough tour through the building is next in order to get all the structural features. After this one may then proceed with the occupancy items as explained above. It is necessary that the new building be inspected very carefully, for there is no old survey to foretell what may be expected. It is all new and the surveyor must go slowly if he is to make sure that all details are found. The old saying that "haste makes waste" is applicable to inspection work. Buildings have been given a fire-resistive rating when they should have been put under the brick schedule and brick-veneered risks have been given the brick rating when the frame rate should have been applied and all because the inspector was in too big a hurry. Later the error is found by a more observing rater, the rate is increased, and then the assured wonders whether his risk is going to burn down or whether he is getting an unfair deal.

Inspection work, like any other line of endeavor, may be performed efficiently or it may be done in a haphazard fashion that calls for the least amount of exertion. But such inaccurate practices do not pay in the sure course of time. The fire insurance inspector has a double duty to perform, one being in the interests of the assured and the other for the companies, himself and the bureau for which he works. It is the schedule man who follows his work with a real zest for knowledge, who is observing to the point of study and, who, in general, attempts to broaden his powers of judgment, that forges ahead and is finally picked by some company for special work with higher pay.

DRY CLEANING ESTABLISHMENTS

What Can Be Done to Prevent Serious Fire Damage to Risks of This Class Wherever Situated

Results of Tests Made to Determine Efficiency of Various Fire Extinguishment Devices, Reported on by the National Board of Fire Underwriters.

Dry cleaning establishments constitute a class of dangerous hazard to be found in every town, but owners are interested in knowing how to safeguard their places against fire and agents can benefit by giving them the information they seek. The Eastern Association of Dyers & Cleaners has given considerable thought to this subject and H. E. Newell, engineer of the National Board of Fire Underwriters, New York, has written a report of tests made in Atlantic City, showing how these risks may be improved. Mr. Newell's report of the tests is as follows:

Test No. 1 was conducted to determine the efficiency of automatic closing covers for washing machines. A washing machine of the usual type with perforated brass cylinder was charged with 30 gallons of 90 per cent benzol; this machine was provided with connections permitting the introduction of carbon tetra-chloride and foamite, it being the intention to introduce either of these two extinguishing agents in case the automatic closure of the cover failed to extinguish the fire.

The metal used in the construction of the link had a fused point of 155 degrees Fahrenheit; the fusible link was attached to the cleaning machine by means of a metal chain, the link being located about 4 feet above machine; a metal plunger or weight was provided to insure tight closure of the cover upon fusing of the link. The test was conducted under ordinary conditions of operation, the machine being located in the dry cleaning room at the plant, operated by Mr. Endicott, Chairman of the Committee on Tests. All windows and doors were closed. The fire was lighted at 3:30—30 and the link fused tripping the cover at 3:30—50, or in other words 20 seconds after lighting the fire. The fire was apparently extinguished simultaneously with the closing of the cover. This test demonstrated the efficiency and desirability of automatically closing covers, not only for cleaning machines but for extractors as well.

CARBON TETRA-CHLORIDE

Test No. 2 was conducted to determine the efficiency of carbon terta-chloride in connection with the extinguishment of fires occurring in cleaning machines with cover remaining open. As previously stated, the machine was fitted with a connection permitting the introduction of carbon tetra-chloride by the opening of a remote control valve. All windows and doors were closed. The fire was lighted at 3:45—20; carbon tetra-chloride was turned into the machine at 3:45—35 or 15 seconds later; fire was out 3:45—46 or 11 seconds after the introduction of the extinguishing agent.

EFFICIENCY OF STEAM

Test No. 3 was designed to determine efficiency of steam for fire extinguishing purposes in dry cleaning rooms. For this purpose, three one-inch pipes attached to the ceiling and running lengthwise in the room were provided; the pipes were perforated containing 216 one-quarter-inch openings; 110 pounds pressure was carried at the boiler. All doors and windows were closed. The carbon tetra-chloride was still in the cleaning machine, but had sunk to the bottom, the benzol about three inches deep floating on the top. The fire was lighted at 4 o'clock; steam was turned on 8 seconds later. By close observation, it was apparent that as clouds of steam came in contact with the flames, the latter subsided but were not extinguished. After a 2-minute interval as the fire was still burning, and in order to prevent damage to the machine, foamite was introduced, which extinguished the fire practically instantly.

USE OF FOAMITE

Test No. 4 was simply a demonstration by the Foamite Company of the sprinkler head developed in conjunction with the Grinnell Company for use in connection with foamite. This head appears to be an adoption of the Grinnell head with separate openings for pipe connections for the two solutions used in the Foamite composition. This head is constructed with a perforated inverted umbrella-shaped hood about 4 inches in diameter placed directly above it. For purposes of the test, four uprights were erected and covered with a plank roof, covering an area of approximately 25 square feet, and duplicating a section of a ceiling. Tanks were placed on the ground directly beneath and the head located approximately one foot below the ceiling; compressed air was used as the expelling agent. The demonstration would appear to indicate that there is considerable merit in this head, but the uneven distribution of the foam indicates that a new standard spacing of heads will probably have to be established.

CONCLUSIONS

From these tests it is obvious that singly or in combination, the foregoing methods of fire extinguishment can be employed, safeguarding the hazard of dry cleaning to a very marked degree. Probably the most impressive demonstration was the effect of the automatically closing cover on the washing machine. It would seem desirable in the compilation of regulations to make the use of such an equipment mandatory for machines and extractors.

From the results obtained by the steam, it would appear that much is to be learned as to the desirable size of pipes, pipe openings, the volume of steam introduced and proper pressure to be carried at the boiler. Probably some standard could be worked out specifying the volume of steam necessary for rooms or spaces of various sizes with residual steam pressure at the boiler of prescribed minimum.

From these tests it is apparent that carbon tetra-chloride and foamite are especially efficient in extinguishing fires in partially closed compartments. The experimental sprinkler head for foamite appears to be meritorious and would seem to indicate extensive possibilities for foam protection through sprinkler systems in buildings of hazardous occupancies.

AUTOMOBILE BRAKE LINING HAZARDS

Explosions and Fires Caused by Treatment of Woven Asbestos with Gilsonite and Linseed Oil— Experience at Manheim, Pa.

Growth of the automobile business has produced demand for a strong, flexible substance for brake linings. Manufacturers are producing these out of asbestos and cotton impregnated with some binding or cementing substance, such as gilsonite and linseed oil. To be applied these are dissolved in a quickly drying material such as gasolene and benzol which has to be driven out again by heating or drying after the material has been impregnated with the mixture. The processes involved in these operations are hazardous because of the imflammable solvents used. One factory is using carbon-tetra chloride as a solvent, having invented a secret method of doing this economically. The cost of this substance has prevented its use in other factories. A number of plants are now producing brake linings and the number is increasing so that consideration of severe hazards involved is opportune. Following is the report on a bad fire in the United States Asbestos Company's plant—the third one it has had—which illustrates well the dangers attending this line of manufacture. Insurance engineers can with profit study this subject in order to suggest arrangement of the hazards with a view to preventing trouble in future.

REPORT IN DETAIL

A fire occurred December 9, 1920, which was caused by an explosion inside a machine for impregnating and drying asbestos brake lining for automobiles.

This machine was about 30 feet long, 8 feet wide and 15 feet high, divided into three compartments. In the first compartment the woven asbestos brake lining, containing about 10 per cent. of cotton, was drawn through a compound contained in a steel open tank about 7 feet square and 2 feet deep, the top of the tank being about 1 foot above the concrete floor. In the second compartment, about 10 feet long and adjoining the first, the lining received its first drying; and in the third divisions, adjoining the second and about 15 feet long, it received the final drying.

The substance used for impregnating is said to be a mixture of 100 *lbs.* of powdered gilsonite and 10 gallons of benzol, to which was added about 3 per cent. of double boiled linseed oil and a little lampblack for coloring. This mixture was prepared in a frame stuccoed building detached at west of impregnating building, by agitating in a mechanical mixer and then pumped to impregnating tank as needed.

The woven asbestos in long narrow strips was drawn through narrow slots in side of machine casing, then over rolls and into and through the impregnating compound, and thence through similar slots to the second compartment. There is passed up and down over a series of rolls and received its first drying, and then through the third set of narrow slots to the third compartment and over similarly arranged rolls where the drying process was completed. The lining said to have a speed of 4 feet per minute through the machines.

The casing around the machine and the partitions between compartments were made of sheet steel, having two sheets about 4 inches apart and the interior filled with magnesia and asbestos fibre. The top casing was of the same construction and was not fastened to the supporting side casings.

Heat for drying was furnished by electric resistance coils located at the bottom of the third compartment and supported on steel racks on the concrete floor. There was a sheet metal cover over the coils to prevent contact with the lining in process above. Heat was regulated to 320 degrees Fahrenheit by a thermostat operating a mechanism on a slate switchboard nearby, which kept the heat within 10 degrees of the pre-determined figure.

The heat was drawn from the third to the second compartment by a motor-driven fan setting on floor of building, outside of and about 4 feet distant from machine. This fan exhausted the warm air from the second compartment and thence to a sheet metal stack extending through and about 20 feet above the building roof. The motor driving this fan had also an automatic stop operated by a thermostat, arranged to cut current off motor if temperature exceeded 350 degrees.

Also there were six steel tanks in box on roof, said to contain compressed carbon monoxide gas, these containers being piped to the second and third compartments of the machine below and arranged to open automatically if temperature exceeded 350 degrees. The purpose of the arrangement was to smother any flame that might develop inside machine.

This machine was designed and installed by the engineers of the American Metallurgical Co. and was supposed to be as safe as it could be made. It is very evident that hazard of process was well known because of the attempts to safeguard it. An explosion and fire occurred in a machine somewhat similar to the one above described on December 7, 1919; after which additional safeguards were added.

EFFECT OF EXPLOSION

The explosion occurred during the ordinary course of operation. Three attendants were in the room at the time, also the president and the general manager of the assured, the superintendent in charge of plant and a chemist who was a brother of one of the higher officials was doing a little experimental testing about 25 feet from machine.

There was no loud report and concussion, the explosion coming more as an expansive puff from within the second compartment of the machine. The sides of the machine fell over outward rather than being blown clear of their position. The men in the room where not knocked down by the concussion, but ran out as soon as they could gather their wits to do so, one of them being struck on the shoulder by a falling roof beam and painfully injured.

The force of the explosion seemed to go toward the north side of the building, knocking down most of the 12-inch brick wall which divided the building into two 50 x 115-foot rooms. Behind this wall a number of men were at work at tables cutting, packing into gaskets. The falling wall caught several of them, injuring three of them severely. Two of these men are still in the hospital and one so badly hurt that his recovery is doubtful.

The explosion also knocked over a large part of the exterior walls at the west and south, so that these are being entirely rebuilt. The 12-inch partition wall at east was not damaged appreciably, a few bricks being loosened in the outside of wall. A considerable part of the plank and timber roof above and to the north of the machine fell, carrying with it the sprinkler piping and putting the sprinkler out of service. A large number of the sprinklers opened according to statement of superintendent, but exact number could not be ascertained because the debris has been cleared away.

Th explosion damaged wiring of assured private fire alarm system, causing the fire signal to be blown automatically by the steam whistle at plant. A large part of the roof took fire, the explosion apparently having spread flame to several places. It was not possible to get any clear idea of what happened as the man in room was too busy getting out to give any attention to other things.

The volunteer department from the town responded quickly with their 750-gallon pumper and soon had three streams playing on the fire, the pumper taking suction from the *nearby creek.* Assured's employees had four private streams in play, supplied by the two city waterworks connections and the 25,000-gallon gravity tank on 85-foot trestle in yard. The damaged sprinkler system said to have been shut off to conserve water for the hose streams. Fire said to have been entirely out at 11:30, 45 minutes after the explosion occurred.

Cause of explosion is not known. Officials of assured have no theory other than that possibly the double boiled linseed oil in the impregnating mixture might have together with the cotton in the asbestos lining caused spontaneous combustion, igniting the benzol vapor. This hardly appears probable because of the small amounts of both linseed oil and cotton.

However, if this process is to be again carried on it should be in a well detached building, preferably of non-combustible construction and so arranged to be damaged as little as possible by explosion. Assured have not decided whether process will again be carried on; for the present will have impregnating done by jobbing it to outside parties.

Before the machine system of drying was carried on, as has been outlined, the impregnated lining was air dried. No trouble was experienced with the air-drying process, although at times large quantities have been in process. The machine-dried lining is said to be more resistant to heat and to give much more satisfactory service than the air-dried product.

FIRE HAZARDS OF GARAGES

Construction—Lighting—Exposures—Class Increasing in Desirability—Ventilation—Use of Power Machines—Private Protection

By W. W. Mouch, Formerly Inspector, Ohio Bureau

Garage risks, while not the most desirable class of business from a fire standpoint, are coming to be considered a more desirable class than formerly, when the losses on this kind of property was much higher.

Automobile repair shops, like the automobile industry, sprung up in a short time, but the various fire-preventive features did not develop nearly so fast, so that an unusually hazardous risk was brought into existence. Garages were started in all kinds of building structures with no private protection and which were not designed for the hazards which they were to enclose. But experience in the wake of time has wrought a great many changes in the automobile risk. Legislation enacted by the state and city, the aid of fire societies, rating bureaus and companies all have helped to reduce the fire hazards of the garage and make it a more desirable form of liability for both the assured and company. With this in view the fire companies should have a more profitable experience with the garage lines in the future. Having had the opportunity of inspecting several of the more modern garage risks, I will attempt to set forth their various features in conjunction with any ideas that I may happen to have from the standpoint of an insurance engineer. Naturally, that is one envolving the eliminating and reducing all hazards to the lowest degree which in turn effects a minimum insurance cost.

CONSTRUCTION

The ideal garage structure of the present day should be of brick construction and of sufficient area as to make it possible to store large numbers of cars and still maintain regular aisles, so that all parts of the building will always be accessible. Where feasible to do so, the structure should be confined to one story with no basement, except a small one for heating apparatus. The storing of automobiles in basements, and repairing in the same, present an undesirable and often unnecessary fire hazard, for the reason that they are rarely well ventilated, which makes them conducive to collecting flammable vapors in places *which are not* the most accessible. The basement may be of sufficient size to contain the heating furnace, which is usually the hot water or steam type. From this heat may be supplied for the entire structure being conducted by iron pipes to steam coils or radiators which are hung on metal brackets. Where steam pipes pass through combustible material, a clearance of 1 inch should be given. Here, also, all other heating outfits, such as gas, hot water heaters and the like may be installed. A final touch is added by the installing of a standard automatic fire door on the basement opening, thus cutting that section off entirely.

While it would make for an ideal building to have the roof of incombustible construction, such as re-inforced concrete, yet it would involve excessive costs, especially if the main part of the roof is of the arched, dome type, which is the more preferable for garages in that it permits thorough ventilation and natural light facilities. This type of roof may be criticized in that it causes large areas which aid the spread of fire. But this hazard can be partially offset by constructing the roof supports of steel and covering the same with an approved roofing.

All flooring should be of concrete or other incombustible material, except in the office section, where wood flooring is not undesirable, if laid on concrete with no air space between, and does not exceed 5 per cent. of the total area.

UNBROKEN AREAS

There is no doubt that one reason so many garage losses are total, is because they are usually large open buildings with no division walls to halt the rapid spread of flames, which is very characteristic of oil fires. This condition can be greatly obviated in the garage risk of today by constructing the risk in three divisions with 12-inch division walls extending through the roof with a parapet of 18 inches in height, and all openings protected by double standard, automatic fire doors. This arrangement makes it feasible to confine one section for offices and show room, one for storing new and used cars and accessories, and the third part for the various features of repairing. In this manner the hazards are well separated, the building being divided into three distinct fire risks and the resulting insurance cost is lower.

The matter of lighting is an important matter in any kind of a fire risk and becomes especially so in a risk of this class. It goes without saying that all electric wiring should be in steel conduit and conform in all particulars to the standards of the National Electrical Code. The bulbs should be of the vapor proof type, so that the "open light and heat" hazard may be minimized. In the repairing department there is need for the frequent use of drop cords and movable lights, which in time develop many wiring defects through the deterioration of the cord. By means of automatic cord winders, which roll up the extension when released, and which are suspended from overhead, this can be eliminated as the cord is always in the air and free from contact with anything except when in use and is not left strung about here and there or wherever it happens to be in use last.

The walls should be constructed of solid brick, stone or reinforced concrete at least 12 inches thick (8 inches if reinforced concrete) with parapet extending 18 inches above the roof on all sides and 12 inches thick. "Open finish" construction in the walls and ceiling is to be preferred, although "ceiled finish" in the office section is not objectionable, provided it does not exceed 5 per cent. of the total area. Ceiled space in walls and ceilings provide convenient places for fires to originate where they may not be discovered for some time and in addition the flames are difficult to check because of their inaccessibility.

Few assureds take into consideration the hazards that their building is subject to, from other risks. A fire rate may be readily divided into three parts, which are construction, occupancy, and exposure. All are of equal importance in determining the amount of fire liability to which any particular risk is subjected. The matter of parapets has already been discussed. However, if a structure is exposed because of windows in the walls, the parapets will not cut off all exposure unless the window openings are protected with wired glass windows having metal frames. Even with conditions as above, a building may still be subject to angular exposure through the roof where other buildings standing close by are much higher.

SPECIAL HAZARDS

Though the automobile repair shop has a number of various fire hazards, yet they are all either directly or indirectly related to the gasoline or flammable vapor hazard. Gasoline vapors and gases given off by running motors are always present, which hang close to the floor and often in such quantities as to endanger the health and lives of employees. No amount of overhead ventilation will correct this condition, so that another means is necessary if this hazard is to be lessened.

This is being accomplished in the modern garage by means of a blower system which is similar to that used in wood-working risks for the disposal of wood refuse. A large fan is installed in one end of the building above the floor some 15 feet or more. The fan is operated by an induction motor of sufficient horse power. A large metal pipe or pipes (depending on the size of the building) are attached to the blower, which are extended in a straight line the length of the building. At intervals ducts are *dropped to the floor* from the main line, thus enabling the system to gather all gases and vapors, which are discharged outside. When it is desired the fans may be reversed to blow fresh air into the building. This feature in the event of fire may easily become an agent in the spreading of flames. So that the air suction in the pipes will not aid the spread of flames, the motor should be equipped with a remote control switch. This fire possibility could also be controlled in another way. The end of each duct at the floor should be provided with an automatic damper controlled through the aid of a fusible link and chain, thus causing the draft to be cut off the moment any flames would come close to the duct.

HANDLING GASOLINE

The operation of gasoline cleaning and washing, handling of gasoline in open receptacles and charging automobiles in the building is being discontinued as it should be, for it presents one of the worst hazards. Automobile men long held the opinion that nothing could be substituted for gasoline in cleaning parts. But time has proven conclusively that there are other methods just as efficient. Probably the best, which is now used by many, is that of hot water. Large metal tanks are installed which are preferably heated by steam. This method presents little or no fire hazard and will do the work as well, although not so quickly, possibly. With the use of the present day outside gasoline pumps, there is no necessity for performing such a hazardous feature inside of the building.

Forging is done in most shops in the form of "burning out" carbon in motors, this method having taken place of the older and safer scraping plan. This substitution has taken place because the "forging" method is quicker and requires less mechanical work. However, I seriously doubt whether fire prevention should be sacrificed for time and trouble. Further it is claimed by skilled mechanics that the "burning out" of carbon is detrimental to the motor. Where such a process is carried on, it should be performed in a separate room for that feature or outside of the building.

In risks with a high combustibility such as the garage, the "open heat and light" hazard is always present and may well be termed a "necessary evil," because of the nature of the risk. Nevertheless this fire possibility can be reduced to a great extent through the installation of standard wiring with vapor proof bulbs and the arrangement of the heating apparatus as described elsewhere in this article. With the above matter taken care of one still has the various gas soldering pots, gasoline blow torches, *oxygen*-acetylene welding torches and sometimes coal forges. *But it is possible* that in the future the hazards of these devices *will probably* be decreased a great deal by the use of electric furnaces, which can be designed to fill the various uses that the above are now used for. In fact, some progress has been made in this line by the use of kerosene torches that are now on the market.

PAINTING AND REBUILDING

Though not found in all garage risks, painting is done in the most of them, and especially so in the risks that deal in used cars, which are rebuilt. This is a hazardous operation under the best of conditions, which rarely exist, for the reason that it is usually a feature which is added later or because the arrangement of the building prohibits any other plan. Like all other processes involving high hazards, it is more safely performed in a separate room for that purpose with a standard cut-off. No open heating devices should be permitted in painting rooms. If due care is to be maintained, the gasoline should be removed from the cars, and all painting accessories such as turpentine, varnish and other material used for thinning should be stored in approved safety cans. When taking these precautions it is best to keep only a day's supply of such materials in the building, the reserve stock being stored outside in a building for that purpose, or in a fire-resistive room.

Battery repairing and recharging presents the same fire hazard as the "open heat and light" hazard, though probably not in the same degree for the reason that battery repair work is usually confined to one section of the building, while "open heat and light" often occurs in all parts. In repairing batteries small gas hot plates are used to heat the kettles containing the tarry compound, used in sealing the batteries. This in itself does not present a serious fire hazard. However, the arrangement of the gas hot plate may cause an undesirable condition, in that they are often set on a wood bench with no protection underneath. Naturally, when the flame is covered a part of the heat is radiated from the kettle and absorbed by the wood which gradually becomes charred, and later when conditions are just right a flame ensues. Large losses often start from a seemingly small hazard, which is in accordance with what someone else has so aptly said, "the largest blazes often originate as small ones."

Another source from which a great many losses have developed is that of "back firing" of motors and motor testing inside the building. A car will sometimes stand all night in the building with a leaky carburetor, causing the place to be filled with flammable vapors. On starting the motor in the morning it may happen to back fire, and if conditions are right an explosion follows. Of course, the testing of motors is a necessary feature of the business, but at times a serious one, not only because of the explosion possibility, but the fire hazard in the car itself is *not to be disregarded.*

The average garage needs little power and what it does require can best be served by electric motors, all things considered. However, there are differences in motors, which are not ordinarily considered. The open, brush-type motor should not be used at all unless it is enclosed according to the standard specifications for the same. But on the contrary this is unnecessary expense and trouble when the induction type of motor can be used just as well without any enclosures. At any rate, regardless of type, the motor is best located, from a fire standpoint, on the ceiling or at least 4 feet above the floor, where such is feasible. In this position it is less subject to dust and flyings, or flammable vapors. At times it is not always possible to locate motors above the floor because of mechanical or structural reasons.

No argument is needed to sustain the statement that the garage risk has its full quota of fire hazards, some of which are often held to be negligible by some assureds, who, through their own lack of appreciation of possible sources of fire, often increase the hazards unnecessarily. This is especially true of oily rags and workmen's greasy clothes. The occupant is sometimes content to allow oily rags to lay about any place where the sun's rays can play upon them or to hang workmen's clothes in small wooden lockers that have no ventilation. Obviously, in the eyes of one, who is acquainted with the results that such conditions cause, they can only be safely taken care of by metal waste cans with self-closing lids and legs at least 4 inches high, and by installing metal lockers which are well ventilated. Posting "No Smoking" signs may seem of small importance, and while their presence is not supposed to completely do away with the smoking hazard, yet they will minimize it, for the average person will comply with the request if he sees the sign at all. If he does not heed its warning, he will at least continue in a more careful frame of mind, all of which is worth something. The chief difficulty is met with the customer who is constantly coming in. But it should be seen to that all employees refrain from smoking not only in garages, but other risks having a high combustibility or where more than 5 hands are employed.

Another hazard which has to do with cleanliness and which is prevalent in all risks where oils are kept in any quantity, is that of using saw dust to soak up oil from the floor. Obviously this habit needs no warning, for its hazard is too apparent, in spite of the fact that so many seem to disregard its danger. In *this connection* I would personally advise the use of sand to *absorb wasted oils.*

PRIVATE PROTECTION

One of the last things to be considered, but not least important, is that of private protection. The approved 1 quart type of chemical extinguishers should be distributed about the building (one for each 2,000 square feet of floor area on each floor) in accessible places. The carbon-tetra chloride extinguisher is preferable to the carbonic-acid type for the reason that they are more effective for oil fires and are more quickly brought into action. In the State of Illinois I understand that the carbonic-acid type is not accepted by the rating bureau in garages at all.

Standpipe and hose systems are never found in the garage risk, nor is their installation advisable. Being intended primarily like the extinguishers, for first-aid use, they are of no value in quenching oil fires, as they merely add to the fury of such a blaze rather than diminishing it.

If the business is not carried on day and night, standard watchman's service should be maintained either in the form of A. D. T. or portable, approved clock. From the standpoint of the assured, the portable clock system is much the better for the reason that it is much cheaper to install, costs less to maintain it, and renders the same service. Of all the various forms of private protection the watchman service is probably the most important. During the day there is always a number about to fight any fire that may start. But after business hours a fire may start from any number of causes, and since, in the case of a garage fire, the first few minutes usually decides whether the loss will be large or small, the night watchman becomes highly important.

Personally, I have had the opportunity of inspecting a great many garages located in all parts of the State of Ohio in the last year, but very few of them would compare with or measure up to the standards which I have discussed above and which I believe are a real necessity in the average garage risk, if it is to be all that it should be, considered from most any viewpoint. But the best of conditions can only be attained through the education of the assured along fire hazards. The right person to give that service is the agent writing the line. So that what is needed is more agents with a thorough knowledge of rating. Then the assured can hope for lower rates, the companies for a better class of business and the public for less loss and waste of property.

LEASEHOLD INTEREST INSURANCE PRACTICE

Deducting Interest for Unexpired Term; Necessity for Fire Clause in Policy; New York and New Jersey Statutes

By William A. Riordan, Manager, New York Local Department, Sun Insurance Office

This form of insurance, in most cases, is very desirable, but is not solicited by most companies because of the limited knowledge of the underwriters on the subject, or, in the case of those more versed, they find considerable time is consumed in explaining to the average broker the extent, if any, of the insurable interest existing. It very frequently develops that the assured has been misled into believing he has something to insure by some one who did not understand this form of insurance. This somewhat disagreeable situation could be remedied considerably, if not corrected altogether, if more were known on the subject. This appears to be a particularly desirable time for the broker to solicit this form of insurance as business is very quiet and the broker can devote more time than he could if business were booming. It is with the thought of helping develop whatever knowledge brokers have of this class of business and to enable the underwriters to acquire a more comprehensive understanding of the numerous features involved that this article was prepared.

INSURABLE INTEREST

The first and more important thing is establishing the insurable interest. It is not sufficient to assume that this exists because a broker or agent submits a line, as my experience has proven that a number of persons confuse the *profits of a business* with the *profits of a lease* and attempt to insure the former as Leasehold Interest.

This insurable interest may result from any number of causes but the one most commonly responsible is in the case where premises are leased, and, in turn, re-leased for a larger figure than is being paid by the first lessee. It is this excess which is the insurable feature. The owner or lessor is never entitled to Leasehold Insurance, nor is the lessee entitled to straight Rent Insurance. There are, however, instances when a lessee agrees to continue to pay rent during the term required to repair a damage caused by fire in which case the lessee should secure Rental Liability Insurance.

FIRE CLAUSE

A very large percentage of lease agreements entered into *contain an express provision* in writing as to the termination of the lease in case of damage by fire. It is this clause which means most to the underwriter since its wording decides when the company must pay. The most satisfactory clause is the one in which the building leased must be totally destroyed by fire before the lease is cancelled. At this point it is well to mention that where the demised premises are only a part of a building and the destruction of same shall operate to cancel the lease, the proposition becomes relatively less desirable than if the termination of the agreement were contingent upon the destruction of the entire building.

Any clause based on other than total destruction, or one which gives the lessor or landlord the sole right to decide when it becomes necessary to rebuild, should be scrutinized very closely, as the lessor may consider it profitable to demolish the undamaged portion of a structure in order to rebuild and make a new lease at a much higher figure which would result in a handsome profit to him.

Fire clauses vary very much in their wording all the way from total destruction to a simple untenantable condition.

I have seen a clause which provided * * * in the event that the premises hereby leased shall be rendered untenantable by fire the lease shall be cancelled * * * This is very undesirable and should not be written as it places no limit as to the extent of the damage. Such a clause would result in a total loss under the leasehold policy and a comparatively small loss to the building policy, which is manifestly unfair, since both policies are written at the same rate. I do not intend to convey the thought that we cannot accept commitments under any but a total destruction clause. I have issued policies which contain clauses giving the lessor the right to rebuild if in his opinion the damage is extensive enough to warrant same, but these policies are on fireproof structures, which under the most unusual circumstances are not likely to be damaged severely, and therefore would not pay him to rebuild.

When a lease does not contain a fire clause the Common or Statutory Law of the state where the property is located takes precedence over the conditions of the lease. The wording of the laws of New York and New Jersey are as follows:

NEW YORK STATUTE

"When any building which is leased or occupied or so injured by the elements, or any other cause, as to be untenantable and unfit for occupancy, and no express agreement to the contrary has been made in writing, the lessee or occupant may, if the destruction or injury occurred without his fault or neglect, quit and surrender possession of the leasehold premises, and of the land so leased or occupied; and he is not liable to pay lessor or *owner rent* for time subsequent to the surrender."

NEW JERSEY STATUTE

"Whenever any building or buildings erected on leased land shall be injured by fire without the fault of the lessee the landlord shall repair the same as speedily as possible, or in default thereof, the rent shall cease until such time as such building or buildings shall be put in complete repair; and in case of the total destruction of such building or buildings by fire or otherwise, the rent shall be paid up to the time of such destruction, and then, and from thenceforth, the lease shall cease and come to an end; provided always that this section shall not extend to or apply to cases where the parties have otherwise stipulated in their agreement of lease."

It is well to insist that a fire clause be made a part of each contract issued as it prevents collusion between the parties to the agreement, which is remote, as the moral hazard is investigated closely, but as the element of human nature plays a big part in our business collusion is always possible.

AMOUNT OF INSURANCE

I have always maintained that it is contrary to good underwriting to issue a policy for an amount equal to the full profit to be realized by the assured during the term of his lease, which would place the assured in a position to profit as the result of a fire. This would be brought about in the following manner: The policy even though it have a depreciating feature would agree to pay the assured not exceeding the amount of the policy less so much per month for the time that had elapsed from the inception of the policy to the day of the fire. In this way the assured would receive at one time an amount which if he did not have a fire he might not get for several years, and he would thereby benefit as he could invest a large sum so acquired to a much better advantage than the sums realized monthly. This was not contemplated when the form of policy was adopted, as all we are expected to and should do is to indemnify for actual loss.

The foregoing contention is shared by a number of experienced underwriters and several of the companies have drawn new forms, which provide for the reduction of the amount of insurance by a certain rate of interest ranging from 4 to 6 per cent (this percentage, however, being optional with the individual company), but, in my opinion, 4 per cent is fair as an average interest rate. In other words, after the amount of prospective leasehold profit is determined, the company will proceed to arrive at the amount at which the policy will be issued by deducting from the principal sum whatever rate of compound interest for the term of the lease they decide on. The result of such operation would be an amount which if invested at the interest rate used in computing same would produce a figure equal to the total prospective income of the assured during the term of the lease. I have attempted in a limited way to distinguish between the method of granting insurance under this form in the past and the plan of incorporating the interest feature which should be generally adopted, as it pays the loss and no more, which cannot be said of the old method.

When the sub-leases are equal in term to that of the original lease, it is entirely in order to issue a policy for one, three or five years, as the assured has what appears to be a guaranteed income under the terms of the sub-lease; but in the case of his inability to secure a tenant whose lease will terminate at the same time that his does, or in the event that he chooses not to grant sub-lease for as long a period, having in mind the possibility of rents increasing as a general thing, or the particular neighborhood improving so that he will be in a position to secure a higher figure three years hence; the policy should not be written for an amount greater than the actual profit accruing to the assured during the term of the sub-lease. In other words, if a man rents a building for a term of ten years at a yearly rental of $10,000 and sub-leased it for two years for $20,000 per annum, he would not be entitled to more than $20,000 insurance less the interest feature referred to above, which is his profit for the term of the sub-lease at $10,000 a year. Some persons have an idea that the company should grant $100,000 insurance, based on the full term of the original lease. This is neither right nor possible as he may not be able to re-lease the property at anywhere near the price he is getting now.

Another form of Leasehold Interest which is offered the companies quite regularly is that which is sought to indemnify the assured in the event that he loses his present premises and is obliged to make a new lease either at the same location or somewhere else at a greater figure than he is now paying. Granting insurance under this form must be done with utmost care, and the term of the policy should not exceed *one* year in order that each individual contract may be reviewed as it comes up for renewal, as conditions may have changed during the life of the contract, which in the judgment of the underwriter will make it undesirable business. This eliminates the need for keeping the suspense files choked up with a lot of daily reports necessary to periodically review long term policies.

The most troublesome feature under this form is the granting of an equitable amount of insurance. The plan usually adopted is to limit the amount of insurance to the increase of rent the assured would have to pay during the next two years of his present lease. If a man has a ten year lease made three years ago, at $10,000 per annum, which has advanced in value to $20,000 per annum, it would probably be safe to issue a policy for $20,000, which is the estimated increased rental for two years. I have consulted with a number of real estate experts who agree that rents in mercantile establishments cannot possibly come down in less than that time, because of the high cost of labor and building materials, which make it necessary to charge unusually high rentals to get a fair return on an investment.

It is not practicable to introduce the interest feature in this form of Leasehold Insurance, as we are insuring against a probable expense instead of a prospective profit.

CO-INSURANCE

When a form does not provide for a gradual reduction of the amount of insurance a co-insurance clause must be used to protect the companies.

It is poor underwriting judgment to use a non-depreciating form on a policy insuring the last year of a lease as the assured's profit diminishes as the lease draws towards its maturity and an insurance policy should not pay a profit which does not exist at the time of the fire. This would happen and would tend to create a very severe moral hazard if a man had a policy which would pay him $10,000 profit the month before his lease expired, when that was his profit for a full year. A depreciating form would only pay him $833.33, which is 1/12 of $10,000, and all he is entitled to.

The depreciating form is the best and should be used whenever possible.

A Leasehold offering should never be accepted unless the Fire Clause accompanies same and is found to be acceptable.

In summing up the details necessary to pass judgment, the underwriter must know: In the case of the straight sub-lease feature:

Term of original lease and date of same
Rent paid
Term of sub-lease
Rent received
The excess received over the amount paid is insurable for the term of the sub-leases less interest as explained before.

In the case of increased rental value of the leased premises:

Term of lease and date of same
Rent paid

Present rental value of premises (this should be checked up by consulting with a real estate dealer familiar with the property) *only* the excess between rent paid and present value is *insurable.*

PORTLAND CEMENT MILLS

Varied Processes and Hazards—Construction of Plants—Protection—Fire Losses—Use and Occupancy Coverage

By W. M. Krieger, Inspector, Ohio and West Virginia Inspection Bureaus.

Portland Cement is now considered next to iron and steel as our most important building material, and the production of this in the United States now amounts to over one hundred millions of barrels annually. In the United States Government's specification for Portland Cement the following definition is given: "Portland Cement is the product obtained by finely pulverizing clinker produced by calcining to incipient fusion and intimate and properly proportioned mixture of argillaceous and calcareous materials, with no additions subsequent to calcination excepting water and calcined gypsum."

In Ohio and West Virginia two processes are employed for the manufacture of Portland Cement, the dry process and the wet process. The dry process is employed exclusively for the manufacture of cement from cement rock and limestone, and also from limestone and shale. The wet process is employed by plants using marl and clay.

THE DRY PROCESS

Through the middle and southern parts of Ohio and also in West Virginia the dry process is used. The limestone is blasted with dynamite or broken with pneumatic drills from the quarries and transported to the mill either by steam, electric power or gravity railroad. The limestone is first broken up, as it comes from the quarries, in crushers of the coffee mill type, run by electric motors. The clay is transported by the same method as the limestone. Both the clay and limestone are dried by being passed through slowly rotating iron cylinders which are either heated by coal or natural gas. The limestone and clay comes into direct contact with the flame and the gases pass out of the dryers into either metal or brick stacks. The clay and limestone after being dried are mixed in the proper proportion and stored in either iron storage tanks or concrete bins. The mixture is then ready for the grinding, which is either done in ball mills or in Kominuter and Lehigh Fuller Mills, and it is ground so that 95 per cent will pass through a 100 mesh sieve. The ground raw stock is stored in iron hoppers placed at the upper end of the kiln mills.

The kilns are constructed of steel, cylindrical in shape, and are from 60 to 150 feet long. They are lined with 8 inches of fire brick and set at an angle and are rotated slowly by individual electric motors. These kilns are heated by pulverized bituminous coal and the fuel is introduced with an air blast at the delivery end of the kiln. The finely ground raw material is fed at the upper end of the kiln, passing slowly through at a gradually increasing temperature until it comes out at the delivery end in the form of a clinker. The temperature of the kilns while in operation runs from 2,000 F. to 3,000 F.

The clinker when coming from the kilns is quenched with water and then passed through coolers. There were two types of coolers found, the horizontal and the vertical. The horizontal is a metal cylinder from 20 to 30 feet long and 3 feet in diameter and rotated slowly by an electric motor. The vertical type is a metal cylinder somewhat larger, with shelves and plates arranged so that the clinker will pass through slowly. In both types air is forced in at the delivery end to aid in the cooling.

The clinker is then conveyed to the finishing mill, where it is ground either in ball and then tube mills or in the Griffen type of mill, and finally in the tube mill. The clinker is ground so that 92 per cent will pass a 100 mesh sieve. In order to regulate the set of cement, since the clinker ground alone would set very rapidly, it is necessary to add to it calcium sulphate in the form of gypsum. As this can be most easily mixed with the cement during grinding, it is the usual practice to add the retarder to the clinker before the clinker is ground. The amount of gypsum runs from two to three per cent of the weight of clinker. After being ground the mixture, which is now cement, is conveyed to either the storage bins or direct to the automatic sacking machines, which blow the cement into bags.

In the cement mills of Ohio and West Virginia, pulverized bituminous coal is used for fuel in the kilns. The coal is first crushed in iron mills and then elevated to an iron hopper over the drier. The drier is a revolving iron cylinder with an additional iron cylinder on the inside and the whole is set at an angle from the feed to the delivery end. A brick furnace at one end furnishes the heat and the hot gases pass through between the inside wall of the larger cylinder and the outside wall of the smaller cylinder, the coal tumbling through the smaller cylinder. The dried coal passes from the delivery end of the coal driers and is elevated to hoppers by bucket conveyers. The coal then passes by gravity through a metal chute to the grinding mills, where either the ball or tube type, or Fuller or Bonnet mills grind the coal to a fine powder. The coal is then conveyed *to the kiln room* by screw type conveyers. The conveyers are of *an enclosed metal type* and deliver the coal into small storage hoppers in front of each kiln. The coal is automatically fed from the bottom of the hopper by a screw conveyer enclosed in an iron pipe, the end of which is connected to the air blast pipe leading to the kiln head. The pulverized coal as it falls from the feeder into the air duct is met by a blast of air which forces it into the kiln in such a state of distribution as to insure rapid and complete combustion with intense heat. The flow of fuel is controlled by a geared friction wheel run from a line shaft while the air is controlled by a slide valve in the branch pipe from the general air blast.

THE WET PROCESS

The operation of the wet process plant differs from the dry process only up to the point where the mixed ingredients enter the rotary kilns, from which latter point the methods and hazards are identical. In the northern part of Ohio, in the Lake Erie district, the wet process is used. In this process the raw stock consists of marl and clay, both being handled while in the moist condition. Marl is a natural deposit of carbonate of lime ranging from 40 to 90 per cent of carbonate. It is found in the marsh lands along Lake Erie and is taken from its deposit by steam shovels and conveyed to the plant by small steam railways. The clay is transported by the same method. At the mill the clay and marl are mixed together with water and stored in tanks, from whence it is fed into tube mills, which grind it into a thin slurry. From the tube mills it is pumped into storage tanks, where agitation is continued by large mechanical agitators. From these storage tanks it is pumped to hopper feed tanks over the feed ends of the kilns. The slurry enters the kilns in a moist condition, holding from 35 to 45 per cent of water, which is vaporized and driven off as steam as the slurry progresses through the kiln to the delivery end. The process from this point is identical with the dry process as described above.

POTASH RECOVERY

The recovery of potash from the waste gases that are given off from the cement kilns is comparatively new and was found only at one plant in the two states. This plant, The Ironton Portland Cement Company, recovers the potash by means of Cottrell condensers, which precipitate dust from gases by means of electricity. Not all plants have sufficient potash in the raw limestone to make this business a profitable one; however, at all dry process plants, where they use limestone, there is some potash in the waste flue gases. The kiln gases are conducted to the recovery building through a concrete tunnel by means of a large suction fan. A Cottrell condenser is nothing more than a *battery of hollow* tubes twelve inches in diameter and sixteen feet long, with one hundred and twenty tubes to a battery. At this particular plant there are four batteries of these condensers. Down through each of these hollow tubes is suspended a number sixteen wire with a weight on the end to hold it in place. These tubes are placed vertically, side by side, and the kiln gases drawn down through them. A current of 75,000 volts is passed through the wire, which acts as a positive pole, while the sides of the tubes act as the negative pole, onto which the dust is deposited. At half hour intervals the current is shut off and also the flue gases, then automatic hammers knock loose the dust from the tubes, causing it to fall on conveyers, which take it to the bleaching house. The potash salts go into solution when the dust is mixed with hot water in large wooden tanks. The dust is filtered off and the solution evaporated under a vacuum. The product resulting from the evaporation is a mixture of potassium sulphate and potassium chloride, which is sold for fertilizer.

CONSTRUCTION

The majority of the plants in Ohio and West Virginia are of incombustible construction, either of reinforced concrete or skeleton steel, in most cases with unprotected steel work. At most plants the smaller outbuildings, such as machine shop, office, barns, supply houses and in some cases bag storage and repair house, are of ordinary joisted frame construction. At 65 per cent of the plants the coal grinding and drying department is connected to the main building. At the same percentage of plants the power house is detached from the other mill buildings. The contents of the buildings grade incombustible except the coal pulverizing, packing, shipping buildings and bag storage houses.

COMMON HAZARDS

The majority of cement mills use electricity for light and power, either generating the current in their own power houses or obtaining it from a public utility company. Individual motors are usually found running each kiln and mill. In the majority of coal grinding buildings induction or non-brush type motors are used, but some mills use open brush type motors. The main cement mill buildings are not heated. In some cases the office, machine shop, packing and shipping departments are heated either by exhaust steam from the boiler house or by gas, coal or coke stoves. Most of the power and transformer houses are of incombustible construction with boilers well set in brick and metal stacks passing through incombustible roofs. The electric power wiring to motors is in all cases installed in standard conduit, while some of the light wiring is open work and poorly installed.

SPECIAL HAZARDS

The outstanding and most serious fire hazard in a cement mill is in bituminous coal grinding. At 65 per cent of the cement mills in Ohio and West Virginia the coal drying and grinding buildings are connected to either the kiln burning, raw grinding department or finish grinding department, or to all of these, which is not a very desirable feature. In the coal building it is preferable to have the coal drier and coal pulverizer separated by a standard fire wall, with no communicating openings except the openings for conveying machinery. At all plants the coal drier and pulverizer are etiher in the same room or in communicating rooms without a standard cut-off. The coal, after being dried and pulverized, is highly flammable and the dust is subject to explosion if it comes in contact with an open flame or spark. It is desirable that all electric light bulbs in the coal grinding section be encased in vapor proof globes, but in no one case are there any of these globes. Induction type motors are found at most of the plants in these sections. The Ball mill, the Fuller mill and the Bonnet mill are the three grinding devices in use, of which the Bonnet mill is thought to be most hazardous, for the reason that air is used to separate the fine particles of coal from the coarser ones at the rolls. Only one plant has a Bonnet installation. It is desirable that the coal conveyers from the grinding mills to the kiln building should be encased entirely in metal and of the screw type, and this is the case at all of the plants. Good ventilation in the coal grinding room is desirable in order to lessen the possibility of an explosion, but at half the plants the coal dust is very thick on account of poor ventilation.

At only one-half the plants visited did the coal pass over magnets in conveyors or hoppers before entering the mill. At two plants inspected the question came up as to the real value of having magnets on conveyers and hoppers. At one of the plants the superintendent demonstrated that there were already sparks in the mill. By removing one of the plates on the side of a Bonnet mill a steady stream of sparks could be seen while the mill was running idle. The superintendent advanced the idea that the reason the sparks did not set the coal dust on fire when coal was being fed through it, was that not enough air was present for combustion, the mill being practically air-tight. At the other plant the superintendent was under the same impression as to the value of magnets, and in this case Fuller mills were used. Although in some cases magnets might not prevent sparks in the mill, they will at least prevent metal from entering the mill and damaging it to such en extent that an explosion might *occur. Also they* might prevent metal from entering the mill and becoming heated and through accident pass through the mill, causing a fire in the conveyers or hoppers.

At one plant quite a little trouble was experienced, due to the fact that straw was mixed with the coal when received. This straw is put in the bottom of gondola dump cars at the mines to keep the coal from sifting out. When the coal and straw pass through the coal driers the straw often becomes charred and sometimes bursts into a flame. The burnt straw is not seen, but passes into the conveyers and grinding mills, where it comes in contact with the coal dust. The manager at this plant stated that they had several small fires from this source, but he had found no satisfactory method for removing the straw.

The next most serious hazard of the cement mill is found in the kiln room in the storage, handling and method of burning the pulverized bituminous coal fuel, as there appears to be the possibility of a dust explosion due to the delivery of an excess of fuel from the feed hoppers which may happen in an approved system, when through accident or from carelessness the delivery of fuel through the feeding device has been stopped; hence any system which does not provide for shutting off the feed before the air blast ceases, or does not provide shut-off valves, is dangerously defective. At all plants a separate means is provided for controlling the air blast and the coal feed. Also any system which does not feed the coal from the hopper to the kiln by a screw conveyer is defective for the reason that when a screw feed is employed only a certain amount of fuel can be fed at one time and never a large excess. All plants except one employ a screw fed fuel control.

In the kiln building it is important that no woodwork be placed in the immediate vicinity of the delivery end of the kiln where the hot clinker is discharged. At nearly all plants the kilns and stacks have incombustible surroundings.

The rock crushing, stone and clay drying, raw grinding and finish grinding constitute mild hazards with the exception of the stone and clay driers, which should be kept free from woodwork. At many plants the driers are well placed and in incombustible surroundings. It is desirable also that all the transmission machinery, such as elevators and conveyers, be of metal, and this condition is found at all plants.

In the stock house either concrete or metal bins should be used for the storage of finished cement. At half the plants cement is stored in contact with wood. Where wood bins or wood construction is used in a cement warehouse, the moisture from the wood is absorbed by the cement and in case of fire *the wood* will burn very rapidly.

In Ohio and West Virginia all cement is packed in paper and cloth bags and the main supply of bags is kept in some detached building.

The hazard of the potash recovery found in connection with one plant is very mild. It is important, however, that the hot gas tunnels and stacks have the proper clearince from all woodwork. This one plant is of incombustible construction, and has incombustible contents.

All the cement mills maintain their own carpenter shops, machine shops, blacksmith shops, supply houses and the special hazards of these classes are present. These buildings are detached from the main mill and are so small in value in comparison with the whole plant that they do not affect the general classification of the risk.

PROTECTION

The cement mills in this territory are all located outside of public protection, and the private protection, if any, in most cases is of little value. No plant has a standard private yard hydrant system, but many have a pump in the boiler house to which they can attach 2½-inch hose. The hose in most cases is in poor condition and not long enough to reach all the buildings. Private protection from chemical extinguishers is very poor, there being only one or two buildings of all the plants under this protection. About all the plants have a watchman, but in no one case is there an approved system installed. The plants run night and day and shut down only when machinery is being overhauled.

FIRE LOSSES

In the past the fire losses as reported at the different plants have been in buildings of light frame construction. In 1895 one of the plants of this construction was totally destroyed by fire. The plant has since been rebuilt and is mostly of incombustible construction.

A fire which destroyed part of the clay mixing shed at one of the plants was caused by a salamander. At this same plant a loss was experienced in the bag house, but information as to the amount of damage and the cause of the fire was not obtainable.

A loss of $40,000 from an unknown cause was experienced in November, 1908, in the cement storage house at one of the plants.

A cement warehouse at another plant was destroyed by fire, which was caused, it was stated, by sparks from a locomotive. No information could be obtained as to the amount of the loss.

USE AND OCCUPANCY DATA

All machines used at these plants are of American manufacture and are obtainable in the domestic market. Some machines, however, are obtained only on special order. A supply of mill parts and repairs are kept on the premises. The machines are not especially susceptible to fire and water damage. Power is furnished by private power plants operated in most cases by individual motor drive. Two plants obtain power from a public service corporation. No two sources of power are available at any of the plants. Processes are continuous and the destruction of certain machines would seriously affect the output. Raw stock consisting of limestone, clay, and marl is obtained on the premises in all cases, but gypsum is shipped in.

TORNADO DATA

In general, cement mill buildings with masonry walls are considered ordinary as regards tornado hazards, but when the walls are of frame, ironclad or skeleton steel construction the hazard is considered greater than ordinary.

SUMMARY

In general the cement mills of Ohio and West Virginia are good fire risks. The industry is in a prosperous and flourishing condition and the general improvements and construction in the last few years as to the erection of buildings of fire resistive type, the installation of improved coal grinding apparatus, the construction of concrete storage bins, and the elimination of the cooperage hazard, have all tended to make this class of risk a desirable one. The buildings at all plants are covered with cement dust, both inside and out. While a very low class of labor is employed, the plants are under strict supervision and good management. The exact information as to the amount of insurance carried on the buildings and contents was not obtainable at the plants, but it is believed that only buildings of inferior construction are insured, while very little or no insurance is carried on the most desirable ones.

THE DEHYDRATING INDUSTRY

Hazards of Dryers—A Factor in Loss Ratios—Vegetable and Fruit Dessication Uses Are Increasing

Special Agent Paul St. John in Fireman's Fund Record

The underlying principle in the process of evaporation or dehydration is the reduction of the moisture content of fruits or vegetables to such a point that the chief agents of spoilage—bacteria, yeasts and enzyms—are unable to grow.

This industry, though by no means new in this country, has received a stimulus during the war due to the fact that the problem of feeding our immense army in France, far from its base of supplies, had to be solved. A large factor in its solution was the dehydration of fruit and vegetables so that they could be carried in concentrated form on the diminishing number of vessels available in 1917-1918.

Congress in 1918 appropriated about $200,000 to be used in research work that would tend to develop this industry.

Today there are a number of firms that are manufacturing commercial dryers and the industry is growing: the farmer is appreciating more and more the stabilizing influence a dryer or evaporator has on his income where he is raising crops of a perishable nature or crops that require drying in the sun before being marketable, such as raisins and wine grapes in California. The layman may have noticed that the terms dryer, evaporator, dehydrator, are used in connection with this process indiscriminately, and in order to eliminate the confusion a committee, of which Professor A. W. Christie of the University of California was chairman, investigated the nomenclature of dried fruits and vegetables. The other members of this committee were P. F. Nichols of the United States Department of Agriculture, E. M. Sheehan, S. C. Simons of E. Clemens Horst Company, and H. C. Rowley, editor of "The California Fruit News." The committee's findings set forth below will be the standard definitions used as the industry develops.

(1) The same drying nomenclature shall be applied to fruits and vegetables.

(2) The term "dried" is applied to all fruits and vegetables preserved by removal of moisture irrespective of methods of removal.

(3) There are but two general classes of dried fruits or vegetables, namely, those dried principally by solar heat and those dried by artificial heat.

(4) The class dried principally by solar heat shall be designated "sun dried," by which is meant removal of moisture by solar heat without control of temperature, humidity or air flow.

(5) The class dried principally by artificial heat shall be designated either "evaporated" or "dehydrated." The committee finds at this time no sufficient reason for distinguishing between evaporated and dehydrated.

As this paper touches on the subject of dehydrators or evaporators only, it might be well to indicate the classification of the various kinds of dryers used commercially.

There are natural draft evaporators, forced draft dehydrators and the distillation type of evaporators, including vacuum dehydrators.

Natural draft evaporators are familiar to people living in California. These dryers require no mechanical device to force the heated air through them and any sort of fuel may be used. Two representative types in California are the kiln dryer used in drying hops and the stack evaporator used in drying apples.

The forced draft evaporator is of more recent development than the foregoing. There are many firms manufacturing different kinds of this type. The underlying principle is the same. These dryers consist of either a vertical or horizontal chamber through which air is passed, heated to definite temperature. The material to be dried is placed in the chamber on containers. The method of heating the air varies. In some dryers the air is passed over steam coils; others have a sheet metal furnace attached to radiating pipes—the air is heated by being drawn over the heated surface. A fan, either of a blower or suction type, is used to circulate the air. Experimentation, strange to say, has demonstrated that a suction fan is more effective than a blower, better results being obtained.

The distillation type of evaporator is usually a closely sealed affair. The fruits or vegetables travel on belts over heated coils. The heat drives the moisture from the fruit or vegetables. This moisture, in the form of vapor, passes over cooling pipes and is condensed, reducing the air pressure in the heated portion of the dryer and thus causing a constant air flow in the dryer.

The vacuum drier is said by Professor W. V. Cruess of the University of California to be the apparatus that turns out fruit of the best marketable value. This drier has to be so constructed that it will withstand the unequal air pressure and is usually manufactured of boiler plate.

The chamber is hermetically sealed after the fruit is placed therein, and a vacuum pump and vapor condenser operate as soon as the temperature is raised to 100 degrees Fahrenheit or 120.

The temperature used in driers of types other than the vacuum type varies from 120 to 165 degrees. Some driers placed on the market are of fireproof construction throughout; others, being of wood construction, are hazardous from the point of view of the fire insurance business.

Dehydrators will be one of the factors in determining loss ratios and rates in sections of the country where they are used.

Some dehydrators recently put on the market indicate that an attempt has been made to consider the principles of fire prevention in their manufacture.

The food stuffs dried in these dehydrators have considerable monetary value and owners, realizing the fire hazard, always want protection.

At the present time dehydration or evaporation taken in the larger sense is only in an experimental stage and until dehydrators become to a certain extent standardized, fire insurance companies cannot profitably underwrite the business unless care in personal inspection of each risk accepted is used.

The writer inspected a home-made product that was used in drying raisins. It consisted of a canvas tent out in the hot sun. A round hole had been cut in the side of the tent to permit the entrance of a stove pipe through which the hot air passed into the tent. The stove pipe was connected to the hot plate of a mud oven, situated about ten feet from the tent. The fuel used was brush and wood. A blower on the intake end of the stove pipe was operated by the fly wheel of a tractor. The tent contained about two tons of raisins on trays. As a fire risk for an insurance company to accept it was beyond the pale, and yet unless personal inspection had been made, the increase above the ordinary hazard would not have been known.

FIRE HAZARDS OF GRAIN ELEVATORS

Construction of All Parts of Buildings and Proper Installation of Heating, Lighting and Power Plants, Handling of Grain and Disposition of Waste

By W. W. Mouch, Insurance Engineer

Involving, as they do, many various fire hazards of high degree, grain elevators probably can be said to be some of the most hazardous fire risks. Not only being subject to fire from several direct causes, they are also in danger indirectly of fire brought on by a dust explosion or because of a tornado, from which fire usually ensues. A large amount of discussion has been carried on in the last few years in regard to the fire hazards of elevators, especially as to dust explosions, so that this paper may add its "drop in the bucket" to the already swelling river of finely developed information.

While the grain elevator will always be a more or less hazardous risk, yet its condition can be bettered no small extent by taking various precautions that will be discussed at length later on. As a rule, conditions are found to be better in the larger grain risks as regards both construction and the numerous protective features and worse in the smaller country elevator. Between the two the latter is usually in greater need of all possible measures of precaution, because it is generally without any public water protection.

Construction hazards form an appreciable share of the fire hazards that are found in the grain risk. These deficiencies in construction often contribute to increasing other hazards even more than is realized by the unsuspecting public. Being rather high in comparison with the ground that it covers, the frame or ordinary brick construction elevator forms a veritable flue that is especially susceptible to fire, tornadoes and explosions.

NEW TYPE TESTED

Recent years have seen an increased tendency toward building re-inforced concrete grain elevators. They are quite expensive for the average grain dealer and it will be some time before they become general, so that it is not my purpose to go into their features at any length here. This type is most desirable from a fire hazard standpoint as well as from other viewpoints, though when a mishap occurs from explosion a greater loss results than in the other type, because the resistance which reinforced concrete offers to an explosion tends to pen it up, with the result that it causes greater destruction when it assumes great enough proportions. This is being partially overcome at the present time by constructing the top part of the walls very light as compared with the lower part. This arrangement of course allows the walls to give way more quickly, serving as a vent to the force of the explosion, which is always out and upward. A recent grain dust explosion in a large terminal elevator in Chicago tested this theory to the satisfaction of the designers.

CONSTRUCTION HINTS

Like anything that is to stand well, the elevator should have a substantial foundation constructed of stone or brick, which entirely encloses the structure and should not be built upon pillars or left open so that it will be subject to a heavy draft underneath and a dumping ground for all kinds of dust and refuse which the wind may happen to bring along. There is little difference between the frame and brick construction, except in the walls, though the brick elevator is more preferable from a fire standpoint. If the risk is to be built entirely of wood, the outside walls should be completely covered with metal, which is to be provided with a good metallic contact at the eaves and grounded with two grounds. Floorway construction, to me, has always seemed a highly important matter. So many of the elevators are practically open from top to bottom, all of which causes dust to be falling constantly from one floor to the next, and it is dust that is suspended in the air that is most susceptible to fire and explosion. Further such a condition permits an unchecked channel for drafts in the event of fire; therefore, it would seem only logical to have each floorway fully covered with flooring and all openings protected except for a few belt holes which are as a rule difficult to cover. Floorways of heavy mill construction covered with three layers of heavy matched flooring will make them about dust proof. If this is not sufficient, then non-combustible compositions may be introduced between the flooring, which will give further dust protection. All stairway and other floorway openings should be cut off by trap doors made of at least two thicknesses of ⅞ inch matched pine laid at right angles and covered with tin sheets 14 x 20 inches, weighing 107 pounds to the box of 112 sheets. The traps should be automatic in closing by means of fusible links, chains and weights, so that they will work quickly in case of fire.

Ordinarily "open finish" construction in the walls and ceilings is considered the least hazardous type. However, I do not believe such to be the case in the grain risk, because the many corners, crevices and the like formed by the heavy joists in an open ceiling or wall only afford a suitable place for dust to collect. *The closed* ceiling and wall would eliminate this. With the floorways built as outlined above, the ceilings and walls tightly ceiled with metal or some other incombustible material, all electric wiring in steel conduit and the hollow spaces between joists effectually cut off from one another, it is my contention that a much better condition would be had than otherwise, so far as the structural hazards are concerned. Provided the open ceiling and wall is regularly swept down and dust not allowed to accumulate, then they would probably be even less hazardous than the ceiled finish, but the task of sweeping in this degree is rarely done in the grain elevator. Hence my reason for favoring the ceiled finish in the elevator, if it is properly constructed. Joists channels in walls can be cut off at each floorway by filling in with brick or concrete, while the channels in the ceiling can be provided with incombustible "stops" every 30 feet or more often, if it is desired. Arrangements of this sort prevent the spread of fire in concealed spaces and leave a small possibility of the entrance of any foreign substance which might cause a fire. Such "cut offs" are especially desirable in the walls, since so many fires start in the basements and spread rapidly to other floorways through the communications afforded by open joist channels.

REFUSE IN BASEMENT

Most of the elevators have basements, some of which are used for one purpose or another, and others seem to be only a place for dust to pile up. The elevator basement should be on a par with all other floors in most all ways. Housing, as they do, machinery of various kinds, they should be thoroughly accessible, which can only be accomplished through giving it sufficient depth, light and ventilation. Where feasible at all it is well to provide them with a concrete floor, a matter which, if nothing else, facilitates the saving of grain which drops down or is hurriedly thrown out of the grain boot which sometimes is overloaded and chokes. In addition it will aid good "housekeeping," of which more will be said later.

Specifications for the construction of grain bins is a problem for the millwright to work out, so that what I will say about them will be mostly from the fire hazard standpoint. In the frame elevator the bins are built up of 2 x 4-inch timbers in such a way that they will withstand heavy weight, such as is formed by large deposits of grain. One of the most important features in the eyes of the grain man is that of keeping out all dampness, because grain absorbs moisture very easily, and when enough has been taken on it will "heat." This difficulty often necessitates changing the grain from one bin into another or running it through a grain drier, either of which is extra expense. Even then a loss may be sustained when the grain is sold. Taking this fact into account it would seem essential to have the bin walls of good thickness to minimize this tendency. In addition, the heavier the wall construction, the greater will its fire-resisting quality be, what may be termed "slow-burning" construction. Keeping grain as dry as possible is still furthered by having a sufficient amount of ventilation in the top of the building. Plenty of air circulation can be attained by having windows in all sides at the top in conjunction with metal ventilators in the roof. The ventilators should be provided with automatic dampers so that they will close in the event of fire. However, there is one form of structural protection that is usually omitted and one which I believe is a necessity in any grain house and that is by providing spouts to the outside from each bin. Such a provision makes it convenient to let the grain run out on the ground of its own force in the event of a big fire. The controls for the outside spouts should be located on the outside of the building so that they will always be accessible when the entire structure is endangered by flames.

BOOTS AND HEADS

Numerous losses have been the result of choked elevator boots and heads. Such a choke-up, of course, causes the belts to slip, and as a result become very hot if not discovered quickly. Excessive heat is soon generated from which a spark or flame is ignited, which in turn causes a dust explosion if conditions are right, or a fire is started. Flames spread rapidly because of the high combustibility of the dust which permeates the air, and only the quickest kind of protective action will place a fire started under such conditions in control. If a series of explosions are created from which fire ensues, then little can be done except to save surrounding property. If the elevator boot is properly constructed, little trouble will be experienced from the choking of heads, for the simple reason that if the right amount of grain is allowed to feed into the buckets, then the boots and heads will always be able to handle the grain as it comes. Of course it is possible for a foreign object to become lodged in the boot or head or for a bucket to be torn off the belt in some manner, thus causing a choke-up. But possibilities of this kind are responsibilities for the elevator man to look after, so that the chances for such an occurrence are minimized. Constructing a non-chokeable boot involves nothing out of the ordinary. All that is necessary is to provide the elevator legs with an ample clearance from the belts and to install a gate on the conveyor end of the dump where the grain feeds into the boot. The gate is so arranged that it can be operated from above and set to allow a certain amount to feed into the boot in a steady stream. Then in the event that anything goes wrong, the grain flow can be stopped immediately and the power shut down if necessary.

It is my opinion that serious choke-ups could further be guarded against by having each grain leg on a separate clutch, thus permitting of shutting down that particular leg without cutting off the main power, as such a procedure is usually more quickly performed, unless a regular engineer is employed and the risk is equipped with an electric signaling system for such emergencies.

HEATING AND LIGHTING

One of the most flagrant hazards of the elevator is that of "open heat and light," of which the latter is more often found in the grain risk, because it requires little or no heat except for power, which should be in a separate building. Some heat is needed in the office, which presents no serious hazard, provided the office is cut off with solid partitions, and if the stoves are properly protected with metal or other incombustible material underneath, even with the sides and rear and extending at least 18 inches in front. Power furnaces and the like are usually located outside in a separate building, and if not should be by all means. Where heating apparatus is installed in other parts of the building, the source of the heat should be from an outside source. Only hot air or steam heat should be used conducted by metal, asbestos-covered pipes. Of the two, steam is the more preferable, as it can be conveyed in smaller pipes with less hazard attached, if given at least 1 inch clearance from any combustible material, and, where suspended, metal brackets should be used. Additional precaution is necessary in the matter of covering all steam pipes with asbestos, which prevents the ever-settling dust from coming in contact with the live steam pipes. Installing a hot air system would involve greater precautionary measure, which entails still more expense. Such a system requires all that a standard steam heating method includes in clearances, pipe coverings and still more. Further than this, strict attention is to be given the construction of the hot air pipes, which should be made of heavy metal, whose joints are to be substantially riveted together. Solder is permissable to make the joints dust and air proof. All pipes must be suspended by metal brackets or straps. In no case should hot air registers be placed in floors, but should be arranged so that they will be in the wall slightly above the floor, for the reason that if they are located in the floor, then the entrance of dust would take place and naturally would accumulate in the first turn of the duct. As time goes on it would become more and more of a fire hazard. Even with the register situated in the wall, it is necessary that they be provided with fine but substantial wire netting to retard as much as possible the entrance of dust and flying. Still more complete protection is obtained by installing an automatic damper in each one, which is made so by a fusible link attachment. In addition to the automatic dampers located at the register, it is advisable to place dampers at all connections where ducts lead off from the main pipe, where the main duct passes through a floor and where it enters the building. Such protective features of course will prevent a fire from coming out or into the pipes besides making impossible the creation of drafts in time of a fire.

Lighting systems play just as important part in the making of fire hazards as does the heating apparatus and should have just as much attention, for records show that many losses have been the direct result of some lighting defect which probably was not considered serious. Where possible, illumination should be by electricity with all wiring conforming to the rules and regulations of the National Electrical Code. While open wiring may be made safe at the time of installation, yet in the course of use it will become defective through wear and tear, which it is always subject to in the commercial or manufacturing risk. With this in mind it is economical as well as much safer to have all wiring in steel conduit, marble switch boards and metal fuse boxes. It would be tedious and almost a never-ending subject to go into the details of electrical standards in this article, so that only the high spots are mentioned. Electric bulbs are to be of the vapor-proof type and in addition, where subject to injury or breakage from machinery, they should be protected by heavy wire guards. It has been established that a fire can originate from dust collecting on the ordinary bulb, while the breaking of an electric bulb with the proper proportions of air and dust will result in an explosion.

In a great many instances electric power is not available, especially in the smaller towns and villages. Then, naturally, the next best method must be employed. As a rule, the small town elevator without up-to-date lighting facilities uses ordinary kerosene lanterns, which are hung around where needed. In such cases it is recommended that the cold blast tubular kerosene lantern be used. When they are not in use, they should be stored in the office and cleaned at regular intervals, so that they will be free from dust as much as is possible.

ELECTRIC MOTORS

Recent years have seen a change from steam and gas power to that of electric, especially in the smaller manufacturing risk or where a number of small individual machines are used. The grain elevator has been no exception to this in some localities. Electric power in the grain risk has its advantages, in that it is more economical over a period of time, because individual motors can be installed, thus relieving the necessity for running *several machines* when only one is needed or used. Over a course of years this means a saving on the depreciation of machines. Again, motors do not require as much labor. When other forms of power are used and located outside in a separate building, one has a less hazardous condition than with the electric motor, which, however, can be installed so that little danger is attendant. Motors intended for use in risks where dust, flyings and flammable vapors are present should be of the induction type with no slip-rings or brushes on the motor or starting device. As to location, the ceiling is the least hazardous position, though not always a feasible location, because of structural or mechanical reasons, and it is to be admitted that such a place does not permit of easy access for repairing. Regardless of position, all motors should be enclosed in a standard manner, and if this is adhered to the matter of location becomes a neglible one. In the main a standard motor enclosure (sides, top and floor) requires that it be constructed of metal of No. 20 U. S. gauge or some other incombustible material, such as asbestos building lumber or brick, which is to be attached to a metal frame (except brick enclosures) made of angle or tee iron with all joints bolted and riveted. The size of the enclosure depends upon the dimensions of the motor, for the enclosure must be at least three times the cubic measurement of the motor. Without any exceptions under these conditions, the enclosure is to be dust and vapor proof, and to avoid overheating they must be vented to the outside by two metallic conveyor pipes four inches in diameter. Small doors and glass windows are not objectionable in the sides of the enclosure, provided the same are tight fitting and held shut by substantial metal catches. Obviously, openings for belt holes are not permissable, the power being taken away by means of a shaft around which the sides of the enclosure are to fit snugly. All wiring should be drawn in steel conduit and the enclosure should be effectually grounded. In discussing the foregoing the writer has in mind the motor of ordinary size and horse-power. Where motors or generators of the larger types are used, then it would be advisable to install them in a separate power house, located at a safe distance.

In many of the elevators steam and internal combustion engines are still being used for power purposes. As mentioned above, electric power is not always obtainable. The gas or gasoline is probably just about as cheap as the motor so far as fuel is concerned. In the case of steam the cobs are used as fuel to a great extent and saving, as they have no market value and are exceedingly cheap for the grain dealer, but steam power requires an extra man to do the stoking, so that in the end I doubt if it is any less expensive, everything considered.

SEPARATE POWER HOUSE

Constituting, as it does, one of the chief fire hazards of the elevator, the location of the power becomes highly essential at all times. It is not exaggerating to say that it is none too safe when located in a separate building, whose distance from the main building depends upon the construction of both. However, the distance at which the boiler house can be located will always be limited, because of the loss in power that results when it is transmitted by means of a shaft of unusual length. In any event I would suggest that at least a space of 20 feet be given. Power houses of the latest design are constructed of brick three stories in height with no floorways except the first. Roofs are either of the combustible type or re-inforced concrete, which is much to be preferred, because it results in a building of the fire-resistive type and a lower insurance cost. The three-story height allows plenty of room overhead for pipes and furnishes adequate ventilation, which is a real necessity in the boiler house. In the front end facing the front of the boilers the coal bin is located, constructed of re-inforced concrete coming down from the top to within about seven feet of the floor. The coal is elevated to the bin by a conveyor on the outside. From the bin the fuel is conveyed to the boiler by means of metal chutes to an automatic feeder on the boiler. These fuel conveyor chutes should be provided with automatic dampers for the same reasons explained in regard to heating ducts. Directly under the boilers there is a small fire-resistive basement, into which the ashes are dumped from the grates and are taken away from the building by means of a blower system to be deposited on the outside. Extreme care should be exercised in placing the ashes on the outside by making some provision for their storage, so that they will not be scattered about by the wind. Smoke is collected from all the boilers, if there is more than one, by one general stack passing along the back of the boilers and then passes through the side of the building where it connects with a brick stack on the outside. These arrangements in general make for an ideal power house, but, of course, are only found at the present time with the larger risks where a great deal of power and heat is supplied to several other buildings. Their construction involves rather high expenditures for the average grain dealer. Whether a modern structure is built or just the ordinary risk is put up, there are certain features that ought to be observed in preference to all other things.

BUILDING POWER HOUSE

If brick is not used in building the power house, then the *skeleton steel* form of construction should be used with an incombustible floor of concrete or brick. The structure should by all means attain a height sufficient to give a volume of ventilation, which can be further aided by installing large metal ventilators in the roof, which are to be equipped with automatic dampers. One of the more serious fire possibilities is that of stack clearance, especially when the stack passes through a combustible roof. Where such a condition is had the stack ought to have a clearance of 18 inches and still more space is not objectionable. To keep out the weather, a metal hood should be placed around the stack on the top side of the roof. One precaution that is rarely taken in regard to stacks is that of spark arrestors. The hazards from such sparks depend upon the height of the stack, kind of fuel, type of roof and the condition of the premises. Provided the roof is slate metal or an approved composition, the stack is at least 25 feet higher than any other part of the building (elevator) and only coal or gas is used as fuel, then there is little danger from sparks and the arrestor is not a necessity. But if cobs, wood or refuse of any kind is used for fuel, then the spark arrestor becomes important. Even the sparks from passing locomotives have been the cause of many elevator fires. Though always present in some form, yet seldom well taken care of, is the case of fuel, for as a rule it is dumped on the floor in front of the boiler because it is convenient, but little thought is given the fire hazard attached. As the matter looks to me, it would seem advisable to have enough room between the front of the boiler and the outside wall to allow for a separate fuel bin, and, in addition space for the firing and cleaning of the boilers. When the boiler house is of brick construction, I would advise that the fuel room be cut off with a solid 12-inch brick wall, except for openings through which the coal is to feed, which is made possible by an elevated floor in the bin. In this manner a large percentage of the coal dust is retained in the bin and not allowed to escape to settle elsewhere and later cause an explosion. When bins are separated from the rest of the building, as recommended above, provision should be made for ventilation by installing metal ventilators in the roof. Coal dust is known to have been the cause of a number of fires and explosions. A great deal of research and experimental work has been carried on by the Bureau of Mines in regard to coal dust explosion in coal mines. From their work it has been found that coal dust, when mixed with the proper proportion of air and the necessary heat or flame is supplied, an explosion will follow.

Safe-guarding fuel does not end with its being deposited in *the furnace. After being* consumed the ashes must be *disposed of in some manner*, which often is a careless one. Generally ashes are hauled out in a wheel barrow to be dumped wherever it is most convenient or else they are stored in wooden barrels. Of course such methods only create added fire hazards that have no reason for existing. It was explained that ashes are being taken away by blower system in the up-to-date power house. But even though such a system is not available, they may be taken care of in a safe manner by thoroughly wetting them with water hose, which can be attached to the water pumps, boilers or other water tanks that are usually found in engine and power houses. This will extinguish any live coals, eliminating any fire possibility from ashes being blown about by the wind. Further, even under these precautions, it is advisable to dump them at a safe distance from all buildings. But under no conditions would I advise the storing of ashes in the building for they must be removed sooner or later, so that it should be done at once without taking any unnecessary chances.

HANDLING COB FUEL

In some instances cobs are used altogether, or at least as much as is possible. For handling cobs I would advise the same storage as for coal, with certain added features. They should be conducted to the power house through metal pipes by means of a blower system, which carries them into a cyclone located on the roof, from where they are then dropped into the fuel bin. The pipe coming from the cyclone is to have an automatic damper where it enters the building. Cob lines may be attached to the furnace so as to feed automatically, and where such an arrangement is desired provision should be made for any overflow that is liable to occur, by installing an extra pipe which will convey any excess amount of fuel into the bin. Further, it is essential on all such systems that the pipes be securely riveted and constructed of heavy metal. A short distance from where the duct enters the furnace another automatic damper should be installed, so that in the event of fire in the duct, the damper will close, thus cutting off any draft or the spread of fire through the entire system.

As a rule, most boilers of any size are brick encased, but not all are arched over the tops with brick. However, they should be, for this unprotected section of the boiler often gives rise to fire hazards that are superfluous. Wood supports, walks and the like are sometimes found resting on the bare metal surface of the boiler to become thoroughly dried, then charred and finally a flame results. At other times oily waste is pitched up on top out of the way and for want of a better place to deposit it along with other forms of rubbish. Seemingly such practices need no criticism or warning, yet people continue such thoughtless acts. *Therefore, it is* certainly essential to have the tops of the boiler protected. Even then it is not impossible to have a fire from combustible substances on top, because the brick will absorb a great deal of heat, so that more than one course of brick is needed.

GAS ENGINE HAZARDS

Internal combustion engines are still being used a great deal in grain elevators, either because there is plenty of local gas or because they do not require a regular attendant after being started. These reasons are often important, for a majority of the elevators are run by two men and sometimes only one. In large manufacturing risks separate buildings are constructed for housing the engines. But such an arrangement is usually out of the question for the average elevator and also unnecessary because of the small amount of power machinery involved. As regards the gas engine, there are three important things to be taken care of in order to reduce their fire hazard to a minimum, which are: ignition, gas regulator and the exhaust. In the past ignition was accomplished through the medium of an open flame or hot tubes which was a hazardous operation. This system is now very much out of date, and it is doubtful if any will be found in operation, as electricity has taken the place of the flame system. However, care should be exercised in regard to the installation of electric wiring, in that it is to be properly supported, standard switches should be used and should conform to the requirements of the National Electrical Code in general just the same as wiring for lighting purposes. Several different kinds of gas regulators are found that are efficient so far as the regulating of the gas flow is concerned, but are not to be sanctioned from the fire hazard standpoint. Among them are the rubber gas bag, which is subject to deterioration through rotting and the tin-can type of regulator, which is nothing more than a tin can with a closed end inserted loosely into another similar receptacle. The inserted can is attached to a lever on top. The one receptacle is filled about two-thirds full of water or oil. But on account of the poor attention given these devices, there is great liability of the level of the fluid decreasing to a point where it ceases to properly seal the opening between the cylinders and consequently gas can escape to the surrounding atmosphere. This arrangement allows the inside can to move up and down accordingly as the gas pressure rises or falls on its entrance in the regulator. The standard gas regulator calls for construction of cast iron or sheet metal which is to be bolted or riveted together securely, so as to make it air-tight. *If made of cast* iron it should be no less than one-fourth inch *thick at the thinnest* part, and if constructed of sheet metal it *must be at least* twenty-six U. S. gauge. This incases the rubber or leather diaphram which is placed on the inside. Secondly, it should be provided with a one-fourth inch iron vent pipe running to the outside of the building and up to a point at least twelve feet above the ground. Possibly of the three the exhaust pipe carries with it the greatest hazard, if not properly installed, for the reason that it presents a fire possibility whenever the engine is in motion and increases in degree if the engine is operated over long periods at one time. Nor is its attendant hazard entirely shut off after the engine has been closed down, especially when the engine has been running for several hours without stopping. Exhaust pipes absorb an enormous amount of heat, therefore it is essential that they be given a clearance of six inches from all combustible material and should be carried to a good distance above the level of the roof where it intersects. The pipes should be of such size as to carry away the exhaust with no trouble. Where exhaust pipes are liable to come in contact with stock or other movable material that will burn, as oily waste, workman's clothing, etc., they are to be protected with asbestos.

GASOLINE ENGINES

What has been said above in regard to ignition and exhaust applies to the gasoline engine as well as to gas type. The gasoline is even more hazardous than the gas engine, because of the high combustibility of its fuel, though it is to be admitted that some of the gasoline that is on the market today does not compare with that of former years as far as combustibility is concerned. One of the essentials of gasoline power is the location of the supply tank, which should be underground at a point at least ten feet distance from any building. The feed pipe should be iron and located underground, if feasible to do so, and laid so that it will drain back into the supply tank through the action of gravity. The fuel is brought to the carburetor by a pump which is operated by the engine. Feed pipes are often made of soft, light material and laid above ground where they are subject to injury from all kinds of traffic. If they cannot be placed underground to the point where they are attached to the engine, then they should be run along or attached to the engine, so as to get them out of the way of the ordinary passages. The pipe joints are not to be neglected. A leaky pipe has often been the cause of no small amount of trouble and fire losses.

It is not to be construed that the hazards of power are the major ones, because of the rather lengthy treatment accorded above, though they go to make up a weighty factor. However, elevator machinery and its processes are the more important matters to be considered on the subject of fire prevention in the elevator. Much of the older machinery was made of wood for the most part. Recent years has witnessed a departure from the original type, in that more metal is being used and less wood. This "turn in the road" is a part of the wide-spread tendency to substitute with the various metals where at all possible. Where wood does appear in the construction of grain machinery, it is covered with metal, which adds to its fire-resistive characteristics as well as reducing the fire hazard provided it is properly grounded, so as to carry off any charges of static electricity, which are often generated in these machines. Friction between two or more. dissimilar bodies will generate a change of static electricity. Not a little experimenting has been carried on in the Northwest in this direction where so many fires have occurred in threshing machines. It was found that if all moving parts of the machine are wired with No. twelve or fourteen copper wires, which are in turn connected to one common wire that is grounded, no fires will result from static electricity.

FOREIGN OBJECTS IN GRAIN

Entrance of foreign objects into the machinery is frequently the cause of injury to some part of the machine, and often causes an explosion or fire, or both. It is a well known fact among grain men that the farmer is careless in regard to what gets into his wagon. He is just as apt to have a wrench in it as he is to have it in his tool house. Then, too, rocks often are scooped in with the grain or a bolt or nut comes loose and is carried into some one of the machines. Extreme care when wagons are being dumped will eliminate some of these foreign objects, but not all. More complete protection will be attained if all cleaners, scourers and smutters are equipped with magnets ahead to remove all such undesirable objects that unavoidably get into the elevator's cleaning system.

One can very safely assume that if the dust hazard could be entirely eliminated from the elevator, it would be a much more desirable class of risk from an underwriting standpoint. It is true that a part of the dust is fairly well taken care of in the majority of cases, but there are few instances where it is disposed of in a thorough manner. In the handling of dust there are just two important features that are needed, the first being an efficient blower system to conduct it outside the building and secondly, good "housekeeping." The various kinds of cleaning machines have dust collectors which succeed in collecting most of the dust particles, but usually have no provision for conducting the dust away as quickly as should be the case. As has been pointed out, the correct construction of the building will aid in keeping the dust from spreading and collecting. The next problem is that of getting it out of the building and as efficiently and quickly as is possible. This, it seems to me, can best be accomplished by a complete blower system, to which all dust-forming machines are to be connected by an individual duct. All other dust which seeps from the machine or falls from other floors may be also disposed of; it is advisable to install floor sweeps on each floor from the main line of the blower system. Thus all excess dust can be swept up at the end of each day's run and carried away.

Now for a few lines in regard to the blower system, which, if not properly constructed, will add some fire hazard as well as helping to eliminate others, carrying, as it does, dust particles which are highly flammable, it becomes very important to see that they are installed and maintained with the best of precaution. Obviously all pipes are made of heavy metal, which is securely riveted together. Solder should not be used alone, for in the event of fire the pipes would come apart. Solder is only advised for making the duct dust proof.

In general the system is so arranged that one main line runs up and down the building with other main lines on each floor, where needed, that join onto the up and down duct on their respective floors. To the main duct on each floor the individual pipes from each machine are connected, as well as the floor sweep ducts spoken of before. As explained previously, these systems are hazardous, because of the nature of their contents, if not properly installed, and may become a fire spreader. The dust is usually carried through the various ducts by means of a powerful suction set up by the blower. If a fire does occur in the pipes it is quickly spread over the building unless some means of cutting off the draft and flame is provided. To accomplish this automatic dampers should be installed in each duct close to where it connects with the machine and also where it joins the main floor line. Each floor sweep duct should have an automatic damper located at the floor end. Further, it is advisable to have dampers where each main line enters the main building line, which in turn is to have a damper at each floor way that it intersects. The main line blower pipe is to run out of the building to a cyclone located on top of the dust house and from there it is continued into the dust house through the side, preferably where another damper is placed. It has been pointed out how a blower system might become an agent in spreading fire over the building through the drafts that it generates. To avoid this the system ought to have a remote control switch that will always be accessible, so that it may be shut down as soon as fire is discovered.

DUST HOUSE CONSTRUCTION

By all means the dust house should be of *fire-resistive construction throughout* with no openings, except for ventilation in the top and another for removing the contents. Ventilation is effected through the roof by means of metal ventilators. Their size and number will depend upon the dimensions of the building itself. At all events they should be of sufficient size so as to allow ample circulation of air. When it is possible to do so I would suggest that the dust house be located at least twenty feet from the elevator and farther if conditions permit. Though the roof should be of re-inforced concrete, yet it would be in good judgment to construct the same as lightly as possible, so that if an explosion occurs the roof will give way and allow the force of the explosion to spend itself in its upward course, thus resulting in less loss to surrounding property. The force of an explosion may be bottled up temporarily, so to speak, but in the end it only serves to cause it to take on greater proportions as regards its power to move obstacles. In the past the dust house has been a source of much trouble in the elevator, because in some cases they were built in the building and in others they were mere frame sheds located very close to the main building and usually had as much dust piled around the outside as was contained on the inside. Such undesirable conditions can be and should be avoided, if the proper precautions are heeded, as discussed in the foregoing, and if good housekeeping is maintained on the outside as well as the inside. When steam is used for power purposes, it is then possible to provide the dust house with some protection in the form of a steam jet. Though the steam jet is of no value in the event of an explosion, as it would be torn up before it had an opportunity to act, yet it would be of service against an ordinary fire. The main steam pipe should be three inches in diameter and enter at the top of the building. From the main line any number of jets may lead off to distribute the steam, depending on the size of the building. Control of the system is arranged on the outside of the risk by a needle valve.

Strange, but true, is the fact that it has only been in the last few years that any real intelligent work has been performed in the unfolding of the mysteries of dust explosion. Previously there seemed to be the attitude that they were some unknown and unavoidable catastrophe that could not be solved in the twentieth century. A number of large losses in recent years, coupled with the dire need of food conservation during the war, has accentuated interest concerning dust explosion, resulting in some very helpful information being brought to light. Tests have established beyond all doubt that with the proper proportion of air and dust mixed together and a sufficient quantity of head or a spark either caused by static electricity, a short circuit, or from a flame will cause an explosion. The initial explosion is often a small one, but its action stirs up more dust and a second and third explosion, which, of course, soon propogates it to other parts of the risk in less time than it can be explained. Explosion of dust particles involves two operations, one being the ignition of the dust particles, which forms gaseous products, and secondly, the explosion of those gases. One may have a heavy dust cloud with open fires or lights in the midst of it and still an explosion may not result, because the atmospheric conditions are not just right for such to take place. The ease of ignition depends upon the fineness and composition of the material and the amount of moisture held by the dust. Generally speaking, the finer the particles the less moisture it will have and the more durable their suspension in the air. All of which is more conducive to explosion and fire. It has been learned that the pressure developed by grain dust explosion is as high or higher than that of coal dust, indicating that the grain dust is more flammable than coal dust. Some seem to misunderstand just what a dust explosion is in reality, thinking that dust merely explodes, as would a quantity of gun powder or any other high explosive, but such is not true. The various dusts explode in the same manner as gases, which require the proper air mixture with the gas and then the introduction of a flame, spark or some source of heat of sufficient intensity.

GRAIN DRIERS

Grain drying apparatus is not found in all elevators, only a few being equipped for such work. The moisture can be removed from grain by running it out of one bin and elevating it into another bin when no other means is available. A poorly constructed grain drier forms an appreciable fire hazard because of the dust that is ever present. There are a number of different types, some of which are very good, while others are very unsafe. One type that is recognized as being a safe arrangement is the Randolph Drier. It is cylindrical in shape and made of metal, the size depending on just what capacity is desired. In the middle there is another cylindrical tube, much smaller, which conducts hot air that comes through small perforations in the side made for that purpose. The grain feeds through the drier coming in contact with the hot air, after which it is conducted away by a conveyor to be elevated into a bin. The hot air is conducted from the drier by a metal pipe to the outside of the building where it is discharged. A furnace, located outside, furnishes the heat, which is conducted through a metal pipe to the drier. Like other ducts, these should also be equipped with automatic dampers where the duct enters the building, where it enters and leaves the drier and also at the point where it leaves the building. Some systems use steam for the drying feature but this is not considered as desirable an arrangement as the hot air which is aided in its course by a blower. In some instances the air is condensed after leaving the drier and is then returned to be used over again. Though economical this introduces additional fire hazard and cannot be recommended.

Being exposed to a certain amount of dust, regardless of the precaution that is taken, clutches, pulleys, bearings and shafting form a fire hazard that is peculiar to the grain risk, generally speaking, and is to be reckoned with at all times. Friction clutches with wood or fiber shoes are dangerous, though necessary, as substitutes are not always practical. Their hazard increases or decreases according to their location, whether it is very dusty or not, the frequency with which they are brought into action and as regards their accessibility, whether they are ordinarily visible and easy to reach if something gets wrong. As indicated, the hazard is not confined to themselves, such as becoming overheated and bursting into a flame, but it may generate static electricity and ignite a dust cloud. The foregoing is also true in the main of wood bearings, wood rim pulleys, rubbing and slipping belts. The hazard created by wood bearing on heavy duty shafts is not necessary nor should they be permitted to be in existence. If belts are always provided with proper clearances where passing through floors or partitions and treated frequently with resin, little trouble will be encountered by rubbing or slipping belts. Of course a belt will slip when the machine or elevator leg is overloaded, which when it occurs should be handled immediately by shutting down the power, the machine or the flow of the grain, depending which is the quickest to do. There is some hazard attendant to line shaftings, if they are not properly installed. At times they are found in dark, inaccessible basements or other such locations, and running through bins. Hence, follows one of the reasons why the basement of the elevator should be what the name implies and not a mere space under the first floor or a hole in the ground. Where shafts pass through bins, they should be given protection in the form of a heavy, hollow metal tube which encases the shaft entirely.

DAILY INSPECTIONS

Statistics show that a large part of the fire loss is due to negligence in one form or another, and it is a prominent cause in the long list of losses in grain elevators. The matter of oiling machinery and the various bearings is a duty that is not attended to in a systematic way. As a rule bearings are widely distributed over the elevator from top to bottom. During harvest time when things are rushing, the machinery is in operation overtime, ranging from twelve to fifteen hours a day in some localities. It is during these rush periods that the machinery should be looked after carefully each day, so that all machines are known to be in perfect working order and that they are well supplied with oil. Due to the widespread and sometimes rather inaccessible locations of the shafts and bearings, careful inspection and care cannot be maintained except through personal rounds by an employee at the end of each day's run. If the work is excessive it may be necessary to inspect them during the day as well. At any rate they should be looked after when closing down, for it is then that conditions are apt to be the worst, although a fire may not break out till late in the night. For these reasons it would not be advisable to have a mechanical oiling system, whereby the machinery is supplied with oil by means of a pumping system. Only hand oiling will accomplish the task in a safe and efficient way. Protection of bearings with metal enclosure might be worked out successfully, though I have never seen any, provided they were of sufficient size as to make impossible the running hot of the bearings. Ventilation could be afforded by placing very fine wire netting in the sides of the hood. Such enclosure would succeed in keeping out some of the dust particles and confine a fire within for a while.

Exposure radiated by railway locomotives is a hazard that is always present, though not in as high a degree for some as for others. In some instances the main line passes within a short distance from the building and occasionally it is quite a distance away, the building sometimes being on a spur which departs from the main track at quite an angle and such being the arrangement, the exposure is much less. As pointed out elsewhere in this discussion, the construction of the elevator has much to do with the railroad exposure. The grain risk constructed of brick or frame with iron clad sides and a roof covering that is combustible is much less subject to such a fire possibility than are those otherwise constructed. But there is still another feature quite as important as the other two. This is no other than the condition of the premises about the elevator. It is not uncommon to find an elevator with a great amount of rubbish around it, such as collections of corn silk, dust cobs, old lumber, wasted grain and weeds as high as the foundation, all of which are superfluous, showing a lack of appreciation on the part of the assured for fire hazards. Accumulations of this sort are contributing forces or hazards in the starting of fires and in the propagation of fire, if it has its origin elsewhere or from another cause. Other exposures are usually prevalent from other buildings, for the average grain business includes several side lines, such as coal, salt, feeds and fence posts. These additional stocks call for other buildings to house them. When the assumed is not crowded for ground, which is rarely the case, the *auxiliary buildings* ought to be well separated by clear spaces so as to eliminate any conflagration hazard. Fire hazards are like some chemicals to a certain extent in that when alone they are not so dangerous, but when mixed with another, a dangerous combination is formed.

SEPARATION OF BUILDINGS

The same is true when minor fire hazards are brought in close contact with one another. Two buildings present a greater fire hazard when joined together than when separated by clear space, so that the greater the distance the less the exposure hazard until a distance is reached where no exposure exists. Therefore it is only consistent to keep all hazards and the buildings housing them as much apart as is practicable. This idea becomes important in the elevator itself, for the reason that other stocks are often carried, such as baled hay, straw, clover seed and wool, with no provision for their storage. Inadequate arrangement of this nature is the result of a poorly planned building. It is my opinion that stocks of this kind should be stored in separate rooms tightly partitioned from the main parts.

Keeping a clean house has been touched upon at other points in the article, but it will not be amiss to say something definite here. During the harvesting periods when grain is being hauled in large quantities, the building requires daily cleaning if all excess refuse is kept moving out, because no small amount will accumulate in spite of the blower system. "No Smoking" signs should be posted on all floors and their warning strictly enforced. Workmen walking about the building smoking a pipe or cigars are almost taking their lives in their hands, as records will show conclusively. Smoking, if confined to the office, which is a separate room with substantial partitions, is not so very hazardous, but the difficulty lies in the fact that if smoking is permitted in the office, it will be done elsewhere through disregard or carelessness of an employee or customer. Where electric motors are used for power, metal waste cans having self-closing lids and legs four inches high should be installed for the storing of oily rags used in cleaning motors. If it becomes necessary to thoroughly clean a motor, which operation can only be accomplished with gasoline, it should be removed from the building by all means. Workmen's clothing in the elevator soon become filled with dust and grease, which if allowed to hang around in the open present a bad condition. To avoid this, metal lockers should be installed to store working garments in when not in use. Items such as these seem rather small and unimportant to the assured and those not intimately acquainted with fire hazards. Nevertheless, experience proves that they are serious features and have been the direct cause of many ruinous losses.

WATER PROTECTION

Any kind of protection is highly important and of all public protection water is undoubtedly the one of greatest concern. But it is a disconcerting fact that it is also usually the one that is absent in the majority of cases. This, of course, is due to the fact that so many elevators are located in small towns which have no public protection to speak of. When public fire fighting facilities are lacking, then the matter of private protection becomes doubly important. For first aid use the standpipe and hose is desirable protective apparatus in the frame elevator, although hardly more than this, for nobody is going to remain in a frame building after a fire has attained a good start. In a brick building the vertical pipe and hose can be used for just more than first aid. Generally one vertical pipe centrally located with outlets on all floors and basements will serve as sufficient protection in the ordinary elevator. The size of the pipe and the required pressure depends upon the height of the building and the number of floors. Each outlet should be provided with at least fifty feet and no more than seventy-five feet of underwriters' labeled one and one-half-inch unlined linen hose, which is to be held in readiness by an approved type of rack, which permits it to be unfolded quickly by catching hold of the nozzle. The nozzle should be twelve inches in length with a five-eighths-inch orifice. The source of water supply is to be, if possible, from the public or municipal water works. When this source of water supply is not available, then some private system is necessary. In order to insure that private water supply system will furnish an adequate stream of water, they should be arranged so as to make remote any possibility of disruption of the system through breakdowns and so that a large supply of water will always be in reserve. This is perfected by the use of a large water tank of at least ten thousands gallons capacity, and whose height depends upon the pressure that is required to give an adequate stream. In any event it should be high enough and located far enough from the elevator so as not to be subject to any serious exposure from that building. This tank of course is to be kept filled at all times by means of an underwriters' fire pump located preferably in a separate building and run by an electric motor of sufficient horse-power. Fire pumps may be operated by steam, if electric power is not available. In the event that an elevator tank is not used to store a ready supply of water, then it is necessary to have two fire pumps arranged so that one may be started pumping immediately if the other gets out of working order, thus giving an efficient relay system for any emergency that may arise. Pumps should be attached to wells of known quantity as regards their ability to give up large amounts of water.

Authorities on the fire protection of grain elevators agree that the ordinary water barrel with three round bottom pails is the best form of hand protection. Casks and pails should be distributed on each floor and basement at the rate of one for each two-thousand square feet of floor area with at least one on each floor and basement regardless of the size. They should be placed in accessible locations where they will be easily seen, with the pails hung up over the barrel on a metal arm for that purpose. These arms may be attached to a supporting beam or to the wall. Barrels and buckets are to be marked "For Fire." The main objection to water barrels and buckets is that they are often used for other purposes and not in position when wanted. If the water casks are subject to freezing, at least three pounds of calcium chloride should be put in for each gallon of water. This solution will prevent freezing and tends to keep the water sweet. The two and one-half-gallon type of chemical extinguisher is not practical for use in the elevator, being subject to freezing, and their design does not permit of as easy and effective use as does the water bucket. In addition to the pails on each floor one one-quart carbon tetrachloride chemical should be installed at each electric motor or external combustion engine. Water is not only dangerous to use on electric or gas fire, but ineffective. The increased use of the gasoline automobile truck has added another fire hazard to the already long list of fire starters in the grain risk. The farmer is beginning to use trucks to haul grain which means that a great many trucks will be passing in and out of the elevator in the future, as is already the case in some localities. To protect this new hazard, one quart of chemical extinguisher should be installed in the driveway. At least one should be hung on each side of the wall for each grain dump. When trucks remain in the building longer than for dumping, the motors should be stopped. It is doubtful in my mind whether motors should be left running when dumping, for the reason that the falling of the grain from the truck always creates a dust cloud in close proximity of the exhaust pipe on the rear. With conditions just right as regards the dust and air, a "back fire" from the motor would cause an explosion.

Primarily, the man-lift is installed with the idea of saving time and exertion of workmen, but they also could be made to serve as a protective device as well, if properly constructed. As a rule the man-lift runs up and down an open shaft, which is not only dangerous for those using it, but it is, also, a fire hazard. Such shafts should be enclosed with at least two thicknesses of seven-eighths-inch matched pine from top to bottom with an opening at each floorway protected by standard, tin-clad fire doors, made automatic by means of fusible, link, chains and weights. In addition it would be advantageous to cover the entire surface both inside and out with tin sheets 14 x 20 inches, weighing one hundred and seven pounds to the box of one hundred and twelve sheets. Further it should have some kind of a permanent light, an electric light being the more preferable if possible. When electricity is not obtainable then a standard cold blast tubular lantern should be used. A man-lift so made would not be very expensive and would afford a safe conveyance at all times in the regular attendance of machinery or for quick access to a fire on the top floors.

Watchman's service, either in the form of A. D. T. service or a portable clock system, is an essential form of protection though seldom found in the small elevators, because the business does not warrant the expense involved. In the large terminal grain house watchmen are employed, because they are a recognized necessity and for the reason that the company can afford to maintain it. Watchman's service is like a great many other protective features, which are known to be efficient and desirable but not always practical when considering the size of the pocketbook. The business angle of making recommendations for protecting property from fire hazards has its importance in most every case; so that the insurance engineer must be cognizant of the expenditure envolved in every case if his findings and recommendations are always to be practical from all viewpoints.

HAZARDS OF LUMBERING AND WOODWORKING

Conditions Met With in all Departments of This Business, from Logging, Through Saw Mill, Lumber Yard, Dry Kiln, Planers and Finishers

By Roy L. Nicholson, State Agent, Michigan F. & M.

The woodworking industry is so broad that it is only possible in a limited time like this to touch upon its main features in relation to fire insurance, without entering into the details of its many ramifications. However, in a state like ours, (Wisconsin), there are many opportunities of getting into personal touch with one or more lines of woodworking without having to travel very far afield, so I am going to give you a brief outline of the business as I have found it, pointing out the various hazards with some suggestions as to safeguarding them, and hoping that my remarks may be of some assistance to you as a guide in your future researches.

LOGGING

Every winter the various lumber companies send large crews of men into the northern woods who cut down the trees, trim off the branches, and saw them into logs. It is these branches with their leaves and other growth, generally called "slashings," that in time become quite a menace to the logging and lumbering end of the woodworking business, for when they are allowed to be where they fell, they rot in time under the weather conditions and a fire starting therein from any cause will run as though in tinder. These logs are now hauled, in most cases on sleds, to the point from where they will be transported to the mills when Spring opens up, and here are piled up. And it is while they are so piled and awaiting shipment that the first call for fire insurance generally comes. As the timber lands have been more cut over, the chances of fires running in these woods have increased and every Spring during that period between snow going off and vegetation springing up, we can expect a certain number of fires. If the snowfall has been light, we can be certain of it. What causes these fires is sometimes hard to determine; sparks from railroad locomotives very often, and occasionally fires used by campers and not properly extinguished. But when a fire does start to run in the woods, there is no guessing what kind of a holocaust it will develop into and the history of our country has many terrible examples. For fire prevention and protection one can only recommend seeing that the ground around such logs so piled is kept as clean as possible of brush, "slashings" and dry rot, and the installation of barrels full of water with two pails at each barrel to throw the water with under some circumstances would be a help. It should be remembered, however, that water barrels and pails are of no value unless there are people around to make use of them.

SAW MILL

The next stage is the saw mill where the logs are cut up into lumber. And a saw mill can be anything from a one story wooden shack with a small circular saw and a boiler for steam power all under the same roof, to a two-story structure with a floor above for a filing room built of iron and steel, running day and night, and with a fire-proof boiler house either detached from the mill or "cut off" by a standard fire wall. But most mills, large and small, are of frame construction. Some of the smaller mills are also "dry log mills"—that is, they saw the log dry without first soaking it in water, and these are naturally poorer fire risks on account of the operations creating more dust and a general dryer condition. And one of the principal hazards of the woodworking industry is the dust and refuse.

Wood dust when allowed to accumulate upon the walls and timbers of a building will carry fire like a train of gunpowder, and this fine dust, like the grain dust found in flour mills and elevators, is also subject to explosion hazard when it comes into contact with sparks or open lights.

One of the specifications of a standard saw mill, therefore, and other woodworking plants also, is a coating of whitewash made according to our government standard throughout the inside of the building, or painted with approved fire-proof paint. This coating not only acts as a fire retardant, but also helps to show dust accumulations.

The saw mill usually found in this state is of frame construction, substantially built and rigid to prevent the vibration of the machinery in time throwing the shafting out of line, and whitewashed. The saws are on the second floor and the driving machinery on the first. And generally there is a smaller third floor used for a filing room where the saws are periodically overhauled and sharpened. Lighting is generally by electricity and heating by steam pipes. For fire protection there should be standpipes on each floor of two or two and one-half inch diameter with hose attached in sufficient quantity to reach all parts of the mill. And in addition to that there should be either water barrels and pails or approved chemical extinguishers *distributed. From personal experience I am inclined to favor the water barrel* and pail, for where the uneducated mill hand in case of fire, might forget how to handle an extinguisher, he instinctively knows what to do with a bucket and some convenient water. Smoking should be prohibited. Often in a saw mill one finds a shingle mill or a lath mill—sometimes both—which adds to the hazard, principally by increasing the amount of wood dust and refuse.

And sometimes where there is more of this refuse than is needed for fuel, it is burnt up in a regular refuse burner built for that purpose. The old open pit for burning refuse is now luckily a thing of the past for the sparks that come therefrom were a constant menace to all adjoining property. On a windy day these burning sparks could travel quite a long way. The refuse burner now most usually found is built of iron and preferably lined with brick, is located as far from the mill as practical, and stands from forty to sixty feet high with a diameter of from ten to twenty feet. The top is provided with a screen of heavy metal mesh to prevent sparks from escaping. The refuse is fed to the burner by an endless chain conveyor running from the mill.

In the same way and on a chain conveyor the refuse is fed to the boiler room. And here it is either fed to the boilers automatically or dropped to the floor and fed by hand.

The boiler room should preferably be of non-combustible material, and either "cut-off" or detached. Those plants that have the boiler in a frame addition to the saw mill itself are regarded as extra hazardous risks. The boiler should be in good brick foundations and clear of any combustible material and the boiler room should have ample ventilation. A good safe roof is built of corrugated iron resting on steel beams or truss, but if the roof is wood with a composition of metal top, there should be as much clearance as possible between it and the arch of the boiler or the boiler breeching, and this roof should also be ventilated. When the metal smoke stack from the boiler goes through such a roof it should be provided with a proper ventilating metal jacket to keep it clear of the combustible material. Each stack should also be provided with the metal screen or "spark arrester" at the top, and sometimes one finds a jet of exhaust steam playing into the stack about half way up which not only improves the draft but extinguishes the sparks. The pumps for pumping water either for the boilers or for fire protection are generally located in the boiler room or in an addition to it; also the generators if the mill makes its own electrical current. The steam engine for power is often in the saw mill itself or in an addition to it. The highest percentage of fires in saw mills is 33½ per cent, caused by sparks, and next, 12 per cent of engines and boilers.

LUMBER YARD

After the lumber is cut it is piled out in a yard to dry out and season. This yard should be as far from the mill as possible, two hundred feet being considered a satisfactory distance. Sometimes, however, this is not practical and then a clear space is maintained of only one hundred and fifty or even one hundred feet. And many things enter into the rating of a lumber yard, such as area, height of the piles, fire protection, quality of the ground on which the yard is built, proportion of hardwood or softwood—the hardwood being rated the better of the two. A good up-to-date yard would be built on a grass or sod bottom, with piles ten feet high, under fire protection of water mains, hydrants and hose houses, with night and holiday watchman service. Also do not overlook the old reliable water barrels and pails, and our standard clause provides that there shall be one barrel of water and two pails not more than one hundred and fifty feet apart on every tramway or in every driveway from April 15th until November 15th. Sometimes to conserve space, it is necessary to pile lumber high, twenty-five feet or more, and then the yard will have tramways built out from the mill into the yard to facilitate handling and piling of the stock. The principal causes of fires in lumber yards are 26 per cent attributed to sparks, 24½ per cent to defective kilns, and 22 per cent to locomotive sparks—almost one-half due to sparks of one kind or another.

DRY KILN

Before lumber can be worked up into flooring, moulding, boxes, furniture or many other lines, it must be thoroughly dried out, and here the dry kiln comes into service. And the dry kiln is one of the main hazards of the woodworking industry. About 12 per cent of the fires in all classes of woodworking plants start in connection with the dry kilns. These kilns are as a rule located convenient to the lumber yard, mill or factory, and in most cases when they burn they take other property along with them. A good practical dry kiln is of non-combustible material, walls and roof, with metal doors and heated by steam coils located on the side walls or at the ceiling. But what we generally find is wooden buildings, heated by steam coils on the ground, or by a draft of air blown by a fan through a coil of steam pipes which heats it, this blower arrangement being located in a small room adjoining. The cars holding the lumber are run in on a track raised two or three feet above the floor. Steam coils at the floor are a bad feature as there is always a danger of dust, shavings, small pieces of lumber, etc. dropping down and piling up on them. And some times the pipes rest in contact with combustible material. While with the fan blower system, if a fire is not at once detected, the artificial draft will make the fire so much and blow it throughout the entire kiln. For fire protection, either sprinklers or steam jets are recommended, preferably the latter, for when a kiln is well filled with lumber, there is so much obstruction to the proper distribution of the water from the sprinkler heads that such a system can do little more than just hold a fire in check. Steam jets should be installed so the entire kiln can be flooded and operated by one valve easily handled and located outside. It is also a good feature to separate the kiln into two or more divisions by fire walls running its full length and rising above the roof.

PLANING MILL

The planing mill is usually a frame building, one story high, and lighter and more open in construction than the saw mill. It should be whitewashed and there should be standpipes and holes and water barrels and pails for fire protection. Here is the machinery that planes the lumber, matches it and generally turns it into the "trim" that is used for base boards, siding, etc. If the planing mill has its own boiler house, the specifications should apply as laid down for that of the saw mill. Very often, however, it is possible to use the same steam that is generated to run the saw mill and it is then piped over and operates a steam engine generally located in an addition. Some planing mills are now installing electric motors to run their machinery and while this eliminates the hazards of the steam engine, it has substituted in its place various electrical hazards if the installation is not standard or the equipment in time deteriorates from lack of proper attention. In the planing mill one of the principal sources of hazard lies in the dust and shavings and their disposal, and this is true of all woodworking plants. The most practical and up-to-date method of removing this waste is by the blower system. This consists of a series of metal pipes leading from each machine through which the dust and shavings are drawn up and are then carried into one main trunk line of pipe in which is located the suction fan that creates the necessary draft. This main pipe leads into a separating device, generally called a "cyclone," which is cone-shaped and also made of metal and which should be located outside. In this cyclone the air passes out through a vent at the top, thus preventing back pressure on the fan, while the shavings drop down by gravity into the shavings vault or any other receptacle underneath and here they are either used for fuel or baled and sold.

SHAVINGS VAULT

When the shavings vault is built in the boiler room or as an addition to it, it should be of non-combustible material and be provided with a sliding metal door to the opening which should be at least six inches above the door. As most wood-workers use the shavings for fuel, it is convenient to have their storage place as near the boilers as possible, and many fires start from sparks from the front of the boiler being drawn back into the vault by "back draft" over the boiler room floor, if the opening of the vault is in line with the door of the fire box. Sparks will run also if the boiler room floor is dirty with accumulations of refuse. Vaults built of wood, or even wooden doors to non-combustible vaults, will rot at the bottom or bulge, allowing the shavings to spread over the floor. For fire protection, steam jets with an outside valve as recommended for the dry kiln are the most practical.

WOOD-WORKERS IN GENERAL

The common hazards of the woodworking industry are those of most factories, viz., lighting, heating and power. Electricity is the best medium for lighting as any open light such as gas of the various kinds or oil lamps, are bound to create a hazard in an atmosphere that cannot be kept entirely clean of wood dust. This condition also makes the use of stoves for heating more hazardous than steam. With pipes using either direct steam or exhaust steam from the engine, care should be taken to see that they are hung on metal hangers and that no combustible material is allowed to pile up on or come into contact with them. This warning applies also to small drying boxes or haul boxes where glued pieces or other small parts are dried out. Hot air blown through a system of metal ducts from a large blower fan is sometimes used but this is not so desirable as, in case of fire, these pipes can carry the flames from one part of the plant to another and it is impossible to build any means of "cut-off" in the system. Fire can also start around the fan bearings or the steam coil if the arrangement is not properly installed or given the necessary attention.

Power can be from steam, electricity, water, gas or gasoline engines. Electricity is becoming more popular right along and if the installation is standard, it is about the safest type to use. I prefer not to see individual motors used, however economical it may be, but would recommend as few motors as possible and these guarded against any accumulations of dust and dirt. When gasoline engines are used it is proper to have all gasoline stored outside the building and the installation of the engine *standard. The hazards* of shafting and pulleys are those of *excessive friction* caused by the shafting being out of alignment, insufficient lubrication, or slipping belt—in fact, no more than the results of bad management or "poor housekeeping."

I have already spoken of the boiler house and its construction. 23 per cent is given as the fire percentage due to this hazard so there is yet a lot to be done to safeguard this end of a woodworking plant. Most boiler house fires are from poor construction, so-called "back drafts," insufficient clearance and ventilation around boilers and boiler stacks, shavings in vaults improperly constructed and dust accumulations on boilers or on boiler house roofs.

The finishing processes in the various woodworking lines vary somewhat. Painting and varnishing have their own hazards, especially in the cheaper grades of work where the dipping process takes the place of brush work and benzine is used for a thinner. These dip tanks should have tight fitting metal covers, preferably arranged to close automatically, should have an overflow pipe to the outside, and all open lights should be kept away. If any electric motors are in the same room they should be of the non-sparking type. Absolute cleanliness should be maintained and standard waste cans should be provided in which to keep all rubbing materials such as oily waste or rags which can go afire from spontaneous combustion. These waste cans have self-closing covers and metal legs that keep the bottom of the can clear of the floor. All the main supplies of paints and oil should be kept in a fire-proof building detached from the rest of the plant.

Glue pots should preferably be heated by steam but if gas is used, all piping should be of metal and in good condition, and the use of rubber hose connections should be prohibited.

Care should be taken with the packing materials such as excelsior, paper and straw, and no large accumulations should be allowed in the packing room. Only one days' supply should be brought into the building and this should be kept in metal or metal lined bins and the rest stored in some detached building. In the stock rooms, where the finished goods are stored, every precaution should be taken to keep things clean and tidy, and there should be a watchman service and some handy means of fighting fire, such as fire extinguishers or standpipes and hose.

The woodworking industry is a hazardous one anyhow, making and handling as it does a highly combustible stock. But whatever the processes used or the hazards existing, cleanliness and carefulness will go a long way to make a plant a better risk, and in this branch of our business more than any other "good housekeeping" is a most essential feature. Personally *I would sooner* approve a plant of poorer construction and *not quite up to* standard where care and good management *prevail than the* better built and equipped factory that is being *operated in a dirty,* slipshod manner.

OBSERVATIONS ON FARM [illegible] HAZARDS

Unsatisfactory Condition of Once Desirable Class; Process of Deterioration Under Tenants; Effect of One Large Building Plan

By Nelson H. Simmons, Syracuse, Manager Farm Department, Home Insurance Company

Fire insurance on farm property in New York State has been unprofitable to the stock companies for more than a quarter of a century and years ago a large majority placed the class on their prohibited list, so that at the present time there are not any more than eight or ten companies which will write it at any price. It is, therefore, in the special hazard class and the few companies who do write it are inclined to confine their acceptances to the best farming sections of the state.

It is unfortunate that an industry so essential to the welfare of the people must be thus regarded from a fire insurance standpoint. There has been, however, during the period mentioned a marked disinclination on the part of the younger people to live in the country and the result has been a very considerable percentage of abandoned farms and much difficulty in obtaining good occupants or dependable employees for tenant farms.

When the original owners of what has been a first class farm property die and their children have moved into the city, none of them are disposed to go back to farming and the place is rented. The first tenant is the best one, although he takes more off the place than he puts on it, and when he moves off the next tenant is necessarily less desirable and so it goes.

The same insurance may be continued on the buildings in the same companies that have carried it in the prosperous days and finally the buildings are insured for much more than the entire farm would sell for or perhaps is sold for.

LINES OVERINSURED

These conditions are reflected in the loss ratio and account largely for the inability of stock company examiners to change the result. They may have before them a diagram with the dimensions of the building and by allowing a certain price per cubic foot may produce results showing that the insurance carried to the replacement value is two-thirds or even less, but in [illegible] they are then allowing more insurance than was paid by the purchaser for the land and buildings and the underwriting result over a goodly number of farm risks under such circumstances may easily be imagined.

Few farmers lock their barns at night and they afford resting places for tramps who do not hesitate to smoke in hay lofts or other dangerous sections and therefore fires from causes unknown to the assured form a considerable percentage.

Sometimes, and in fact frequently, the best of farmers have to employ anyone they can get to harvest their crop and save it and these travellers, who will work only a few days at a time, are too unclean to sleep in other than the outbuildings. The farmer knows of the extra hazard and may not be blamed for getting the buildings and contents insured up to as near value as possible. The risk is a good one to look at, but this hazard is not apparent to the company's agent or even its special agent or inspector.

Hay and alfalfa are put into the barns the same day they are cut and there are many and very serious fires from spontaneous combustion. Years ago these crops were well dried before housing and this hazard did not exist.

Necessarily increased rates often result in transfer to county and township mutuals of the risk of the farmers who are most careful in every respect and the stock company is left with a less desirable grade of risks which the increased rate does not make up for.

LIGHTNING HAZARD

The hazard of lightning in the country is a very serious one, classification records of 15 years showing that out of the total losses on farm barns and contents three-eighths of the losses were caused by lightning. Buildings properly equipped with standard lightning rods kept in perfect condition, the same as is required of a sprinkler equipment, for instance, are almost immune from damage by lightning and while the credit in rate allowance for such an equipment is improving this condition, it is not doing so nearly as fast as it should; in fact, every farm barn or outbuilding of any size should be so protected, and while the percentage of loss to dwellings is not as great as barns, they should be similarly protected.

GASOLINE ENGINES

The gasoline hazard is also important, because devices operated by such power are in general use, automobiles, tractors, gasoline engines and milking machines. These devices, if properly constructed and the gasoline supply properly located, may be used without largely increasing the fire hazard, but the temptation is always to purchase the cheaper devices and not bother too much about safety of the storage tank. Portable gasoline engines used for power temporarily most anywhere on the place present a serious hazard, while those installed in a permanent location where attention can be given to safety of installation and surroundings may be used with little increase in hazard.

SEPARATE BUILDINGS

The general tendency to build one large air-tight barn and use it for housing the livestock and all of the farm products has greatly increased the loss ratio as compared with separate buildings for hay storage, cow barns, horse barns, granaries, etc., so that a fire means the burning of only one instead of all the buildings on the farm. Only a few days' supply of inflammable material such as hay, straw and feed should be kept at one time in the cattle barn.

Poultry houses should be separate buildings both on account of cleanliness and if kerosene oil incubators or brooders are used. Kerosene oil lanters should be kept clean and there should be pegs or hooks to hang them on where needed and should never be set down or placed where they are apt to be knocked over and cause fire.

It has been said that the depreciation in farming products from the last harvest time to the present writing is about five billion dollars.

Conditions as to farm property in New York State are not widely different than they are in other states of the East and underwriters therefore may not be blamed if they give the class up as a bad job and conclude that they may more profitably turn their attention to the cultivation of other classes of business which are uniformly more remunerative.

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